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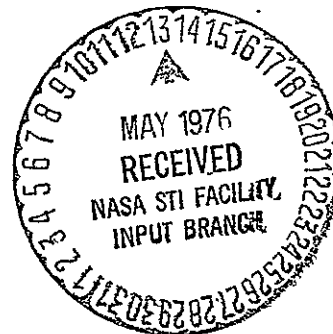
(NASA-CR-147598) SMS CREW STATION (C AND D  
PANELS AND FORWARD STRUCTURES). CEI PART 1:  
DETAIL SPECIFICATION, TYPE 1 DATA (Singer  
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SMS  
Crew Station (C&D Panels & Forward Structures)  
CEI Part I, Detail Specification

"Preliminary" - NASA Approval Pending

NASA Contract NAS-9-14910  
Type 1 Data

Date: 31 March 1976



Singer  
Simulation Products  
Division  
Binghamton, New York

## FOREWORD

This specification is submitted as part of a series of second level hardware contract end item specifications required for the Shuttle Mission Simulator (SMS). These specifications are for the following end items:

- 1 Mission Control Center Interface
- 2 Image Generation System
- 3 Image Display System
- 4 Image Processing and Control
- 5 Crew Station
- 6 Instructor Operator Stations
- 7 Digital Computer Complex
- 8 Power and Grounding
- 9 Voice Communication
- 10 Aural Cue/Caution and Warning
- 11 SCE
- 12 Central Timing Equipment

## Contract End Item Specification - Part I

### Crew Station - (C&D Panels & Forward Structures)

#### 1.0 Scope

This part of this specification establishes the requirements for performance, design, test and qualification of one type of equipment identified as SMS C&D Panels and Forward Structures. This CEI is used to provide all hardware and wiring necessary for the C&D panels to be properly interfaced with the computer complex/signal conversion equipment (SCE), crew station, and software requirements as defined in other CEI specifications.

## 2.0        Applicable Documents

The following documents, of exact issue shown, form a part of this specification to the extent specified herein.

### Standards

Singer Standard Engineering Practices

### Specifications

Addendum "B" to Statement of Work for SMS	Data Management Specification for the SMS
Addendum "A" to Statement of Work for SMS	SMS Design Control Specification

### Military

MIL-B-5087	Bonding, Electrical, and Lightning Protection for Aerospace Systems
MIL-D-1000	Drawings, Engineering and Associated Lists
MIL-E-5400	Electronics Equipment, Aircraft, General Specification for
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aircraft and Missiles
MIL-P-116	Methods of Preservation
MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage

Specifications (Con't)

Military (Con't)

MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-143	Specification and Standards, Order of Procedures
MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-STD-681	Identification Coding and Application of Hookup and Lead Wire
MIL-STD-889	Dissimilar Metals
MIL-STD-1130	Connectors, Electrical, Solderless Connections, Wrapped
MIL-STD-1285	Marking of Electrical and Electronic Parts
MIL-STD-1310	Shipboard Bonding and Grounding Methods for Electromagnetic Compatibility
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-W-16878	Wiring, Electrical, Insulated, High Temperature
USAS Y32.2	Graphic Symbols for Electrical and Electronics Diagrams
USAS Y32.16	Reference Designations for Electrical and Electronics Parts and Equipments.

### 3.0 Requirements

#### 3.1 Performance

##### 3.1.1 Performance Characteristics

###### 3.1.1.1 Primary Performance Characteristics

###### 3.1.1.1.1 Panels

These crew panels shall be faithful representations of those in the OV-102, with the exception of the Payload Station panels and A7 and A8. Components (on the panels) whose function(s) are to be simulated shall operate and cause reaction as defined by approved SMS data. This shall be accomplished by wiring all functional electrical components to the computer/SCE complex and/or other parts of the SMS complex as required. The latter applies to those functions which are independent of software. (For example, crew station lighting and caution and warning volume.) Additional primary performance characteristics of this work package are to provide panel hardware and I/O wiring for normal system simulation of the various systems in the SMS.

The SMS configuration shall include those panels identified in the Appendix.

Aircraft loft lines shall be used to develop the interior of the crew station. Aircraft window data shall be used to duplicate a facsimile of the windows. Simulator instrument panels and consoles shall be at the aircraft orientation dimensionally. The flight controls shall be either aircraft or simulated instruments and controls and will be mounted as they are in the aircraft. Appearance, location and feel shall be as in the aircraft. The Commander and Pilots seats will be GFE but will be mounted similar to the aircraft in location and by superstructure. The FBCS will use the same data as the existing OAS for the forward shell, windows, secondary structure, Controls installation, air conditioning and seat installation.

#### 3.1.1.1.2 Other Components

Shown on the configuration defined in associated line drawings of the Appendix are a number of different types of components. Data pertinent to the procurement of parts required for the SMS Control and Displays are included in the Engineering Design Report.

#### 3.1.1.1.2.1 Indicators and Flags

All Indicators and flags used in the SMS are called out in the Appendix on Table 1. All Power to drive the Indicators will be controlled by LO's where applicable or be part of the software equation in computing the D/A used to drive these indicators.

#### 3.1.1.1.2.2 Circuit Breakers

All circuit breakers depicted on the SMS baseline configuration will be installed. All wired CB trip coils and contacts will be wired to the SCE.

#### 3.1.1.1.2.3 Keyboards and CRT's

Power for the keyboard and CRT's will be controlled from the SCE. Keyboard lighting power will be wired directly to the appropriate lighting control circuit. The CRT will be wired directly to the DEU's. The keys of the keyboards will be wired to DI's, and DEU inputs to DO's.

#### 3.1.1.1.2.4 Aural Warning Devices

Aural warnings associated with the Caution and Warning system shall be provided and simulated.

#### 3.1.1.2 Secondary Performance Characteristics

Not Applicable.



### 3.1.2 Operability

#### 3.1.2.1 Reliability

This CEI shall be designed such that reliability is maximized, compatible with CEI design and performance requirements.

#### 3.1.2.2 Maintainability

The equipment shall be designed for ease of maintenance, accessibility for installation and removal of components, safety of personnel during operation, and minimum time for training problem set-ups.

#### 3.1.2.3 Useful Life

The equipment shall be designed to have a minimum useful life of 10 years when maintained in accordance with the manufacturer's supplied maintenance manual. \_\_\_\_\_

#### 3.1.2.4 Natural Environment

The equipment shall be designed to be capable of satisfactory operation within the performance requirements of this specification and to sustain no damage from the following natural environment conditions:

- a) Temperature - Minus 20 degrees F minimum to plus 140 degrees F for two weeks.
- b) Altitude - Up to 35,000 feet for 5 hours.
- c) Humidity - 0 to 100 percent including condensation.

#### 3.1.2.5 Transportability

The equipment shall be designed to minimize preparation procedures for handling and transport. Features shall be incorporated in the equipment design to permit handling by forklifts and cranes; no special equipment shall be required. Disassembly shall be held to the minimum required to provide adequate protection of the components, but shall not require the use of special tools or skills for reassembly. The largest piece of equipment which cannot be disassembled shall not exceed a crated width of 10 feet, height of 10 feet, length of 16 feet, and weight of 4,000 pounds.

#### 3.1.2.6 Human Performance

Human performance criteria to support the equipment for optimum arrangement, lighting, colors, placarding, and equipment, shall be provided. Human factors requirements shall be applied to assure compatibility between man and the equipment. Unless otherwise specified herein, the human engineering requirements of the equipment shall be in accordance with the following engineering standards as applicable: MIL-STD-1472 and MSFC-STD-267A.

#### 3.1.2.7 Safety

The equipment shall be designed to insure maximum safety to personnel and equipment during training periods and maintenance operations.

#### 3.1.2.7.1 Personnel Safety

The equipment design shall provide for the adequate protection of personnel and crew members at all times. Protective devices shall be incorporated to prevent accidental contact with primary supply voltages or rotating parts.

#### 3.1.2.7.2 Equipment Safety

The equipment shall be designed for optimum equipment safety throughout, as specified herein.

a) Overload Protection - Overload protective devices shall be provided within the equipment for primary circuits and such other circuits as required for protection of the equipment from damage due to overload. These protective devices shall be located in such a manner as to be readily replaceable from the front, either by direct location on the front panel or behind hinged doors or panels, except for power supply and computer complex equipment fuse and circuit breakers. Lamp indicators shall be used so that fuse failures are visually indicated except on the computer complex equipment and similar equipment. All overload protective devices shall be placed in the ungrounded side of the circuits.

b) Heat Dissipation - The design shall provide for the adequate positioning and spacing of components whose operation involves the release of heat at appreciable rates. Location and spacing shall be such as to permit sufficiently

rapid dissipation of heat to prevent excessive temperatures in their immediate environment. Such items shall be contained in cabinets or other suitable enclosures. Enclosure containing such heat dissipating components shall incorporate provisions for removal of heat energy released. Where the rate of dissipation is too high to warrant reliance upon natural convection for cooling, forced ventilation shall be provided.

#### 3.1.2.8. Operating/Induced Environment

The equipment shall be capable of performing its intended functions within the specified performance requirements while operating under any combination of the environmental conditions specified below:

- a) Temperature - +60° F to 85° F.
- b) Altitude - Zero to 2,500 feet.
- c) Relative Humidity - 30 to 80 percent.

### 3.2 CEI Definition

This CEI will be mechanically consistent with the SMS Crew Station; it will be electrically consistent with the characteristics of the computer/SCE complex.

#### 3.2.1 Interface Requirements

##### 3.2.1.1 Schematic Arrangement

Interface with the PDU will be as defined in the Power and Grounding Specification. Interface with the SCE is defined in the Signal Conversion Equipment CEI Specification.

##### 3.2.1.2 Detailed Interface Definition

Not Applicable

#### 3.2.2 Component Identification

##### 3.2.2.1 Government Furnished Property List

Government Furnished Property employed in the design of the FBCS shall include the following:

- 1) Keyboard (3)
- 2) Display Unit and Display Electronics Unit (4) each
- 3) ADI (3)
- 4) Rotational Hand Controllers (3)
- 5) Translational Hand Controller (1)
- 6) Cross Pointer Indicator (1)
- 7) Couches and Tracks (2)

Government Furnished Property employed in the design of the MBCS shall include the following:

- 1) OAS
- 2) Translational Hand Controller (1)

3.2.2.2 Engineering Critical Components List

Not Applicable

3.2.2.3 Logistics Critical Components List

Not Applicable

3.2.3 Technical Manuals

Information for maintenance and operation of this CEI shall be included in the SMS Maintenance Manual (DRL No. 17, JSC No. 11002) and Operations Manual (DRL No. 18, JSC No. 11003).

### 3.3 Design and Construction

#### 3.3.1 General Design Features

The SMS Controls and Displays shall contain components which look, feel, and fit the same as in Orbiter-102.

#### 3.3.2 Selection of Specifications and Standards

Unless otherwise specified, specifications and standards for materials, parts, and processes shall be selected using Standard MIL-STD-143 as a guide.

#### 3.3.3 Materials, Parts and Processes

The following requirements shall govern the selection of materials, parts, and processes in the design and production of the equipment covered by this specification:

a) Where covered by Government specification Specifications and standards for materials, parts, and processes which are not specifically designated herein, will be selected in accordance with MIL-STD-143.

b) Where not covered by Government specifications - Where materials, parts, and processes are not covered by Government specifications, their selection will be at the option of the contractor with the restriction that selection shall meet the performance characteristics satisfactory for the intended use. As an example, connectors will be used exclusively to distribute the branch circuit 60Hz to the various user locations.. These are Underwriters listed but not Mil. approved, plastic type standard shell with a separate pin size selection. There is a

cost saving in their use throughout the system.

Materials that are not specified herein shall be sound, of uniform quality and conditions, and free from cracks, seams or defects which may adversely affect the appearance, strength, endurance or wear resistance of the finished part. Wherever practival, non-critical materials shall be used in construction of the equipment. All nonmetals such as wood, plastic, and fabric used in construction of the equipment shall be of the moisture and temperature resistant type.

#### 3.3.3.1 Flame-Resistant Materials

Where practicable, flame-resistant materials shall be used. Where necessary to use flammable materials, they shall be of such characteristics that neither toxic nor corrosive fumes will be liberated if the material should burn. All flammable materials shall be brought to Program Office attention prior to design approval.

#### 3.3.4 Standard and Commercial Parts

Standard parts such as Air Force-Navy (AN), National Aircraft Standard (NAS), Military Standards (MS) parts shall be used where practicable when they suit the purpose, and shall be identified on the drawing by their part number. Commercial parts having suitable properties may be used where there are no suitable AN, NAS, or MS standard parts.



#### 3.3.5 Moisture and Fungus Resistance

Materials that are susceptible to damage or deterioration due to moisture or salt spray shall be avoided.

Materials that are nutrients for fungi shall not be used where it is practical to avoid them. Where nutrient materials are used and not hermitically sealed, they shall be treated with an acceptable fungicidal agent.

#### 3.3.6 Corrosion of Metal Parts

Corrosion-resistant metals shall be used in the construction of the equipment wherever protective finishing is not practical. Where necessary to use ferrous materials to obtain certain functional or magnetic properties, such ferrous materials shall be protected against corrosion.

#### 3.3.7 Interchangeability and Replaceability

Mechanical and structural interchangeability and replaceability shall conform to the requirements of Specification MIL-I-8500. Electrical and electronic interchangeability and replaceability shall conform to the requirements of MIL-E-5400. All parts having the same suppliers part numbers shall be governed by the drawing number requirements of MIL-D-1000.

#### 3.3.8 Workmanship

The equipment shall be constructed and finished in accordance with the best commercial practice. Particular attention shall be given to the following:

a) Freedom from objectionable blemishes, defects, burrs, and sharp edges.

b) Accuracy of dimensions, radii of fillets marking of parts and assemblies.

c) Thoroughness of soldering, welding, brazing, painting, wiring and riveting.

d) Alignment of parts and rightness of assemblies, screws, and bolts.

e) The equipment shall be thoroughly cleaned. Loose, spattered or excess solder, metal chips, and other foreign materials shall be removed during and after final assembly.

### 3.3.9 Electromagnetic Interference

Equipment design to prevent generation of electromagnetic interference or the vulnerability of the equipment to interference shall be in accordance with MIL-STD-461 and MIL-STD-1310.

### 3.3.10 Identification and Markings

The major items of the equipment shall be durably and legibly marked in accordance with the requirements of Standard MIL-STD-130 and shall include the following information:

Part Name and Number

Manufacturer's type or part number

Quantity this package; lot number (if applicable)

Serial Number (if applicable)

Manufacturer

Date of Manufacturer

Contract Number

In all instances where parts, subassemblies, assemblies and units of the spacecraft equipment are used in the simulator such parts shall be permanently marked with the following precautionary markings in a plainly visible position:

CAUTION: For Use Only in Training Equipment

3.3.11 Storage

Not Applicable

#### 4.0 Quality Assurance Provisions

#### 4.1 Phase I Test/Verification

The CEI shall be inspected in accordance with requirements given in the approved SMS Quality Assurance Plan.

##### 4.1.1 Reliability Test and Analyses

The contractor shall maintain a log of all failures which occur during all test period. This log shall include:

- 1) Part No. of failed part
- 2) Location of failed part
- 3) Short narrative explaining failure
- 4) Number of hours on unit at time of failure
- 5) Number of manhours required to correct failure

#### 4.2 Phase II Integrated Tests

Integrated performance of this CEI shall be demonstrated as defined in the SMS Acceptance Test Procedure. Functional tests to be performed shall include the tests as described in the following paragraphs. These tests will be demonstrated during each systems test that uses the applicable hardware.

##### 4.2.1 Switches

Each operational switch should be operated in all of its positions. Verify that in each case the appropriate "boolean" in the computer changes state, or in the case of switches which are hardwired to lights, the correct light operates.

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##### 4.2.1 Switches

Each operational switch should be operated in all of its positions. Verify that in each case the appropriate "boolean" in the computer changes state, or in the case of switches which are hardwired to lights, the correct light operates.

#### 4.2.2 Lights

Each simulated light should be turned on from the computer by making the appropriate core a "boolean" one or zero as required to operate the light.

#### 4.2.3 Lighting

Lighting controls should be operated and visual inspection should show that all simulated lighting is operational.

#### 4.2.4 Indicators and Flags

Computer outputs should be set up in such a manner as to demonstrate that each device included in Section 3 (Indicators and Flags) drives to the correct position, from the SCE, as defined by approved data.

#### 4.2.5 Circuit Breakers

This test is to be performed when the entire simulator complex is operational.

4.2.5.1 Turn each simulated CB off and ensure that the appropriate core location becomes a "boolean" one or zero as applicable.

4.2.5.2 From the I/S-CRT, provide the correct inputs to trip various CB's one by one. Insure that each selected CB trips in less than one second. While the failure is in, attempt to reset that CB and insure that it again trips in one second. This process may be repeated for each wired CB.

#### 4.2.6 Keyboard

The keyboard should be checked for proper operation during normal acceptance testing of the SMS.

## 5.0 Preparation for Delivery

### 5.1 General

Preservation, packaging, and packing shall be designed to provide necessary protection to all items to prevent damage or deterioration.

### 5.2 Preservation

Items subject to deterioration or corrosion from exposure to the elements shall be preserved by methods necessary to insure adequate protection.

### 5.3 Packaging and Packing

Packing and packaging where specified herein shall be designed to protect the item from damage during transit from the point of manufacture to the receiving activity and during subsequent short-term storage.

### 5.4 Marking

Marking of interior and exterior containers shall comply with the requirements of MIL-STD-129 and all applicable local or federal regulations and shall insure safe arrival and ready identification at destination.

#### 5.4.1 Unit Container

Wherever containers are used, they shall be durably marked in a legible manner in such a way that the markings shall not become damaged when the containers are opened. The markings shall provide the following information:

- a) Part name and number



- b) Manufacturer type or part number
- c) Quantity this package; lot number (if applicable)
- d) Serial number (only if serialized for control)
- e) Manufacturer; date of manufacture
- f) Contract number

#### 5.4.2 Shipping Container

Whenever shipping containers are used, they shall be packed with single or more like items. The shipping containers shall be marked in accordance with paragraph 5.4.1 above, and the supplier's standard marking for address and precautionary handling. Shipping containers packed with unlike items shall be marked with the supplier's marking for address and precautionary handling.

## APPENDIX

The appendix contains a line drawing of each panel to define the exact configuration of the panel to be simulated for SMS, based on Drawing VL70-730102 Revision 1, dated 12/12/75, plus change introduced by Data DTD.6, received February 19, 1976.

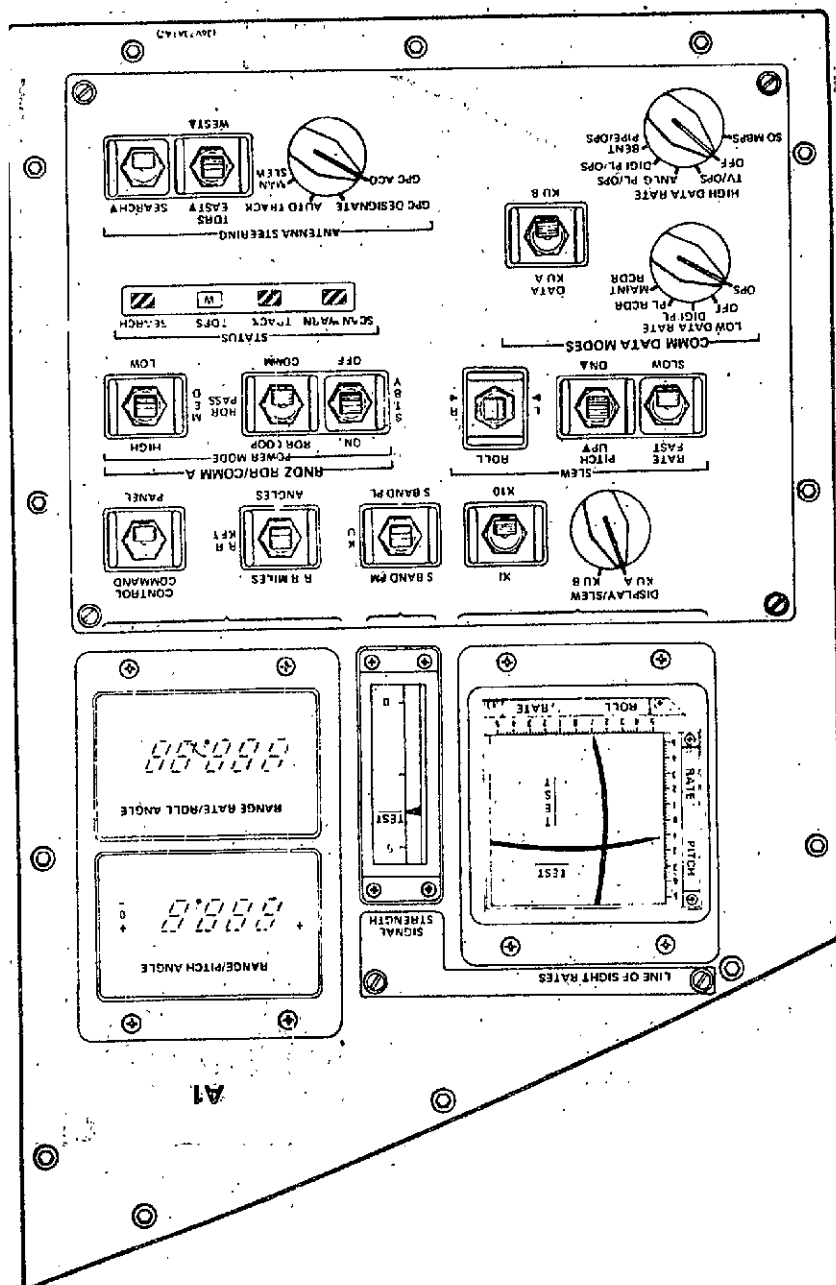
## APPENDIX

The following pages show the OV-102 panels as defined by VL70-730102 Revision 1, dated 12/12/75, and by changes contained in data marked DTD.6 and received 2/19/76.

1. Panel A1A2
2. Panel A1A5
3. Panel A1A3, Panel A1A4
4. Panel A1A1, Panel A2
5. Panel A3, Panel A4A1
6. Panel A6A1
7. Panel A7A1 (RHC only)
8. Panel A11A1
9. Panel A12A1
10. Panel A13A1
11. Panel A14A1
12. Panel A15A1
13. Panel C2
14. Panel C3
15. Panel F1, Panel F2, Panel F4
16. Panel F5
17. Panel F5, RHC
18. Panel F7
19. Panel F8, RHC
20. Panel F9
21. Panel L1A1, Panel L1A2
22. Panel L2A1, L2A2 (SBTC)
23. Panel L4

24. Panel L5, Panel L9
25. Panel 01, Panel 02
26. Panel 03
27. Panel 05
28. Panel 06
29. Panel 07
30. Panel 08
31. Panel 09
32. Panel 013, Panel 014
33. Panel 015
34. Panel 016, Panel 017, Panel 019
35. Panel R1A1
36. Panel R1A2
37. Panel R2
38. Panel R4, Panel R6
39. Panel R10A2
40. Panel R11A1
41. Panel R11A2
42. Panel R12A1
43. Panel R12A2
44. Panel R13A1, Panel R13A2
45. Panel R15A2

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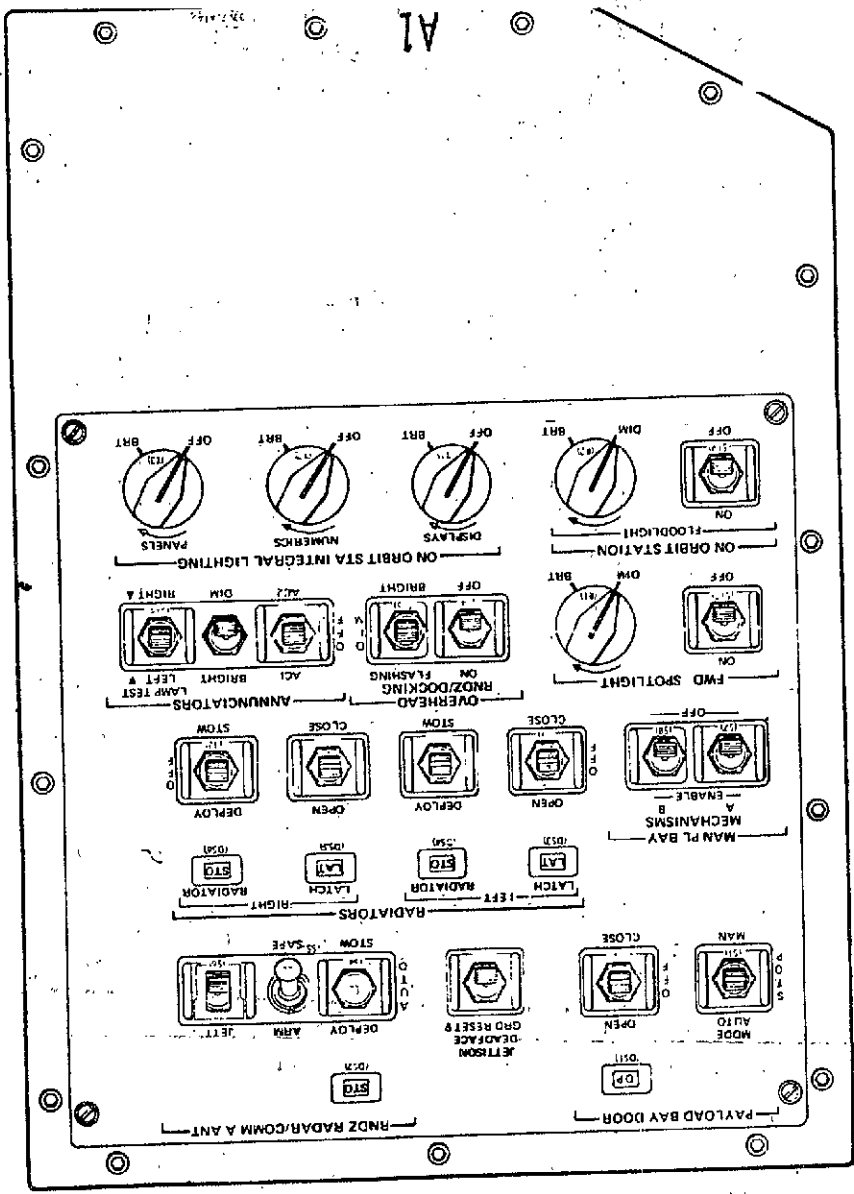


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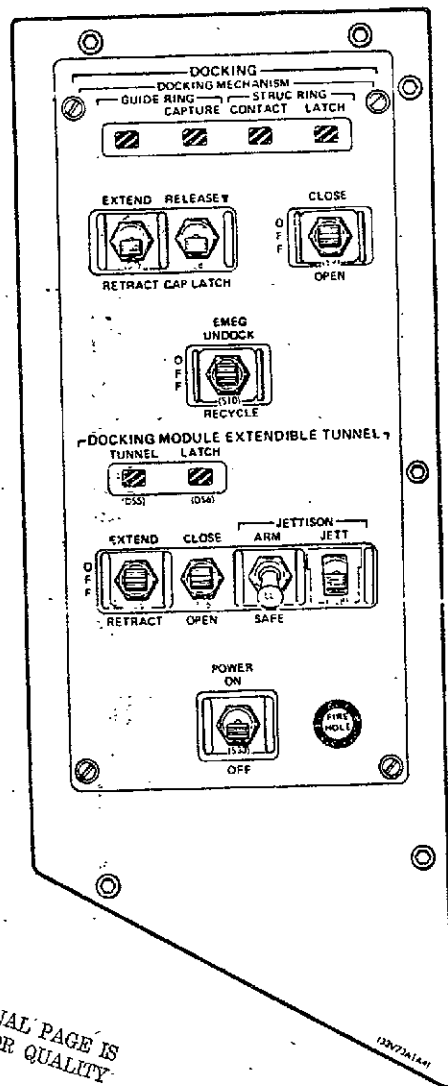
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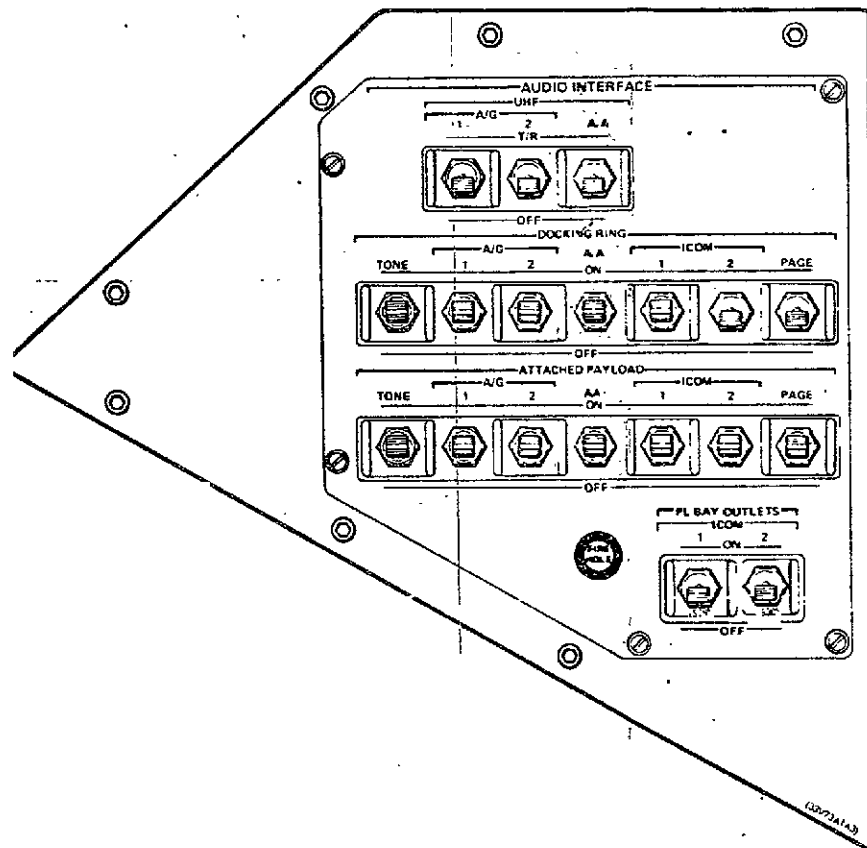
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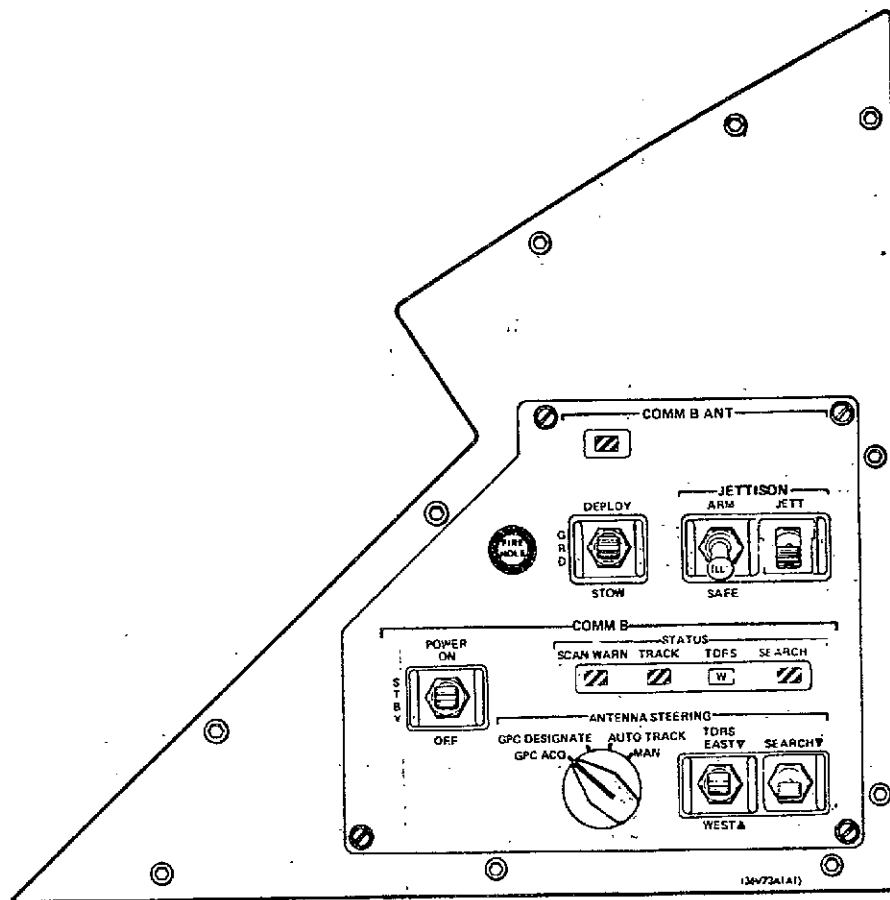
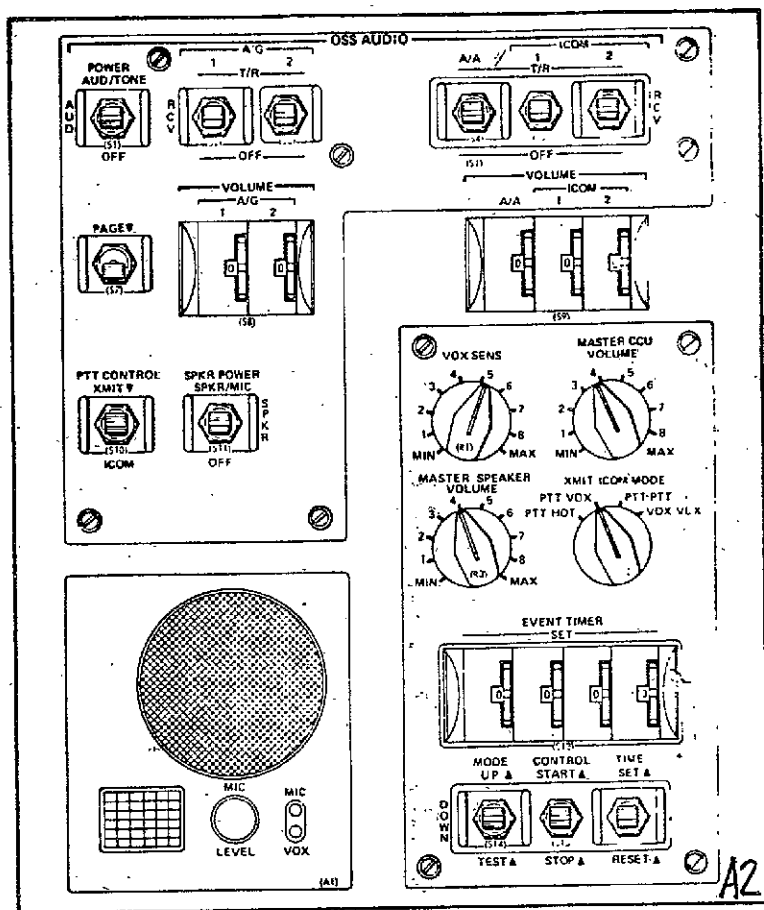
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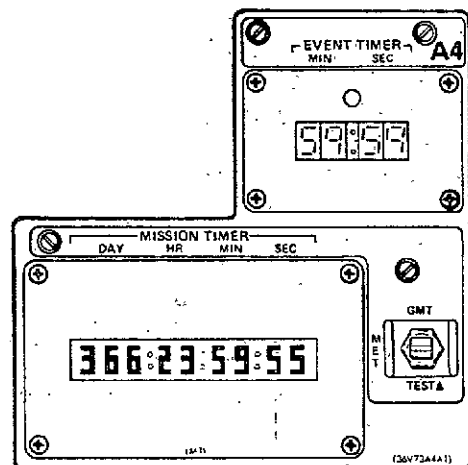
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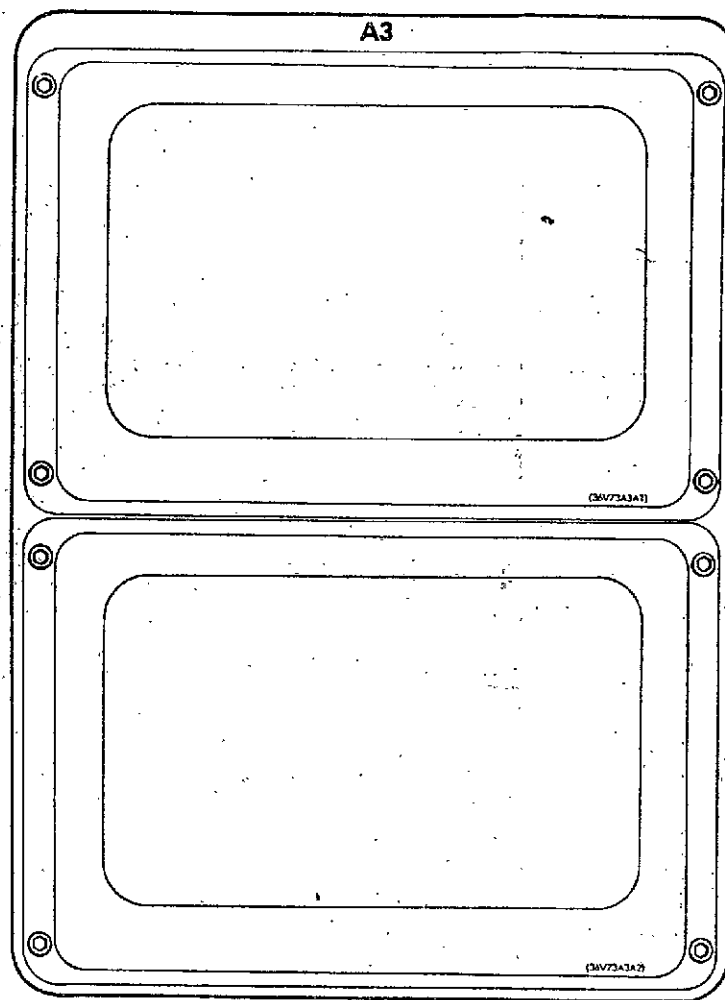
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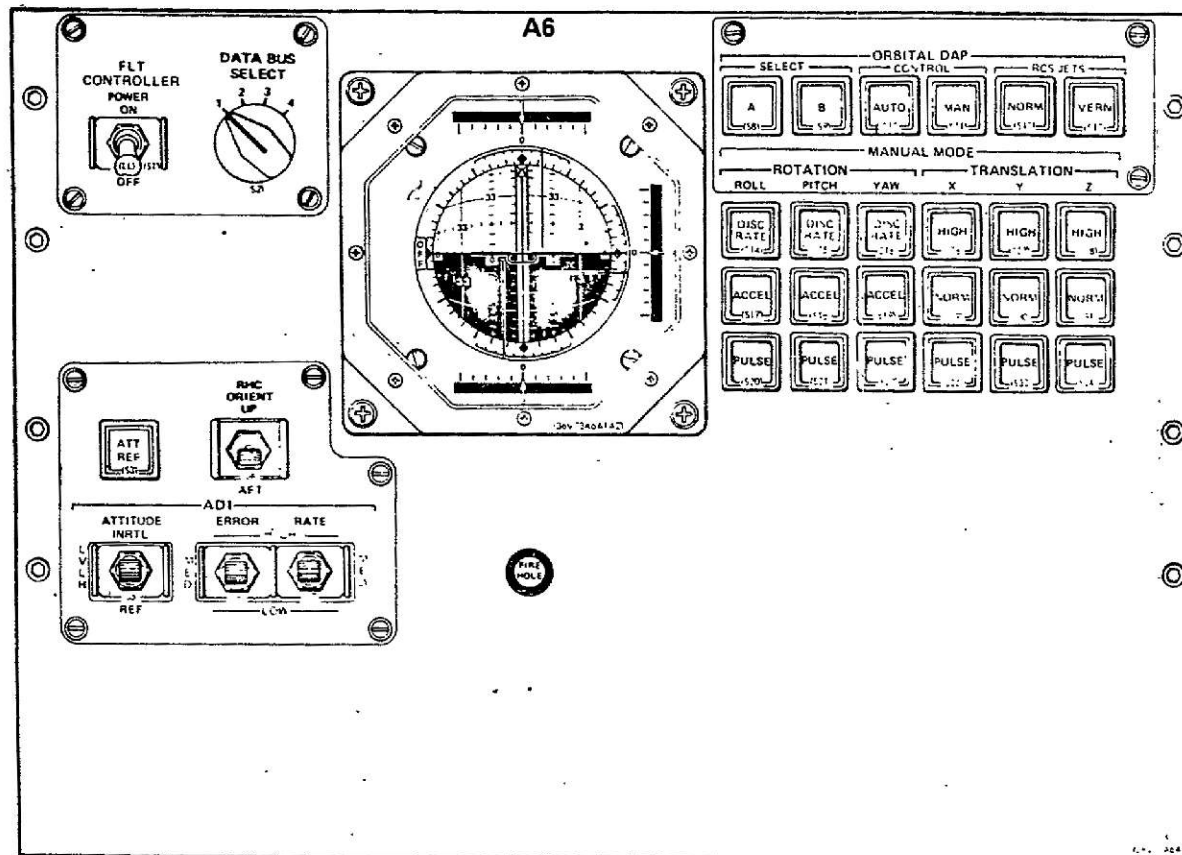
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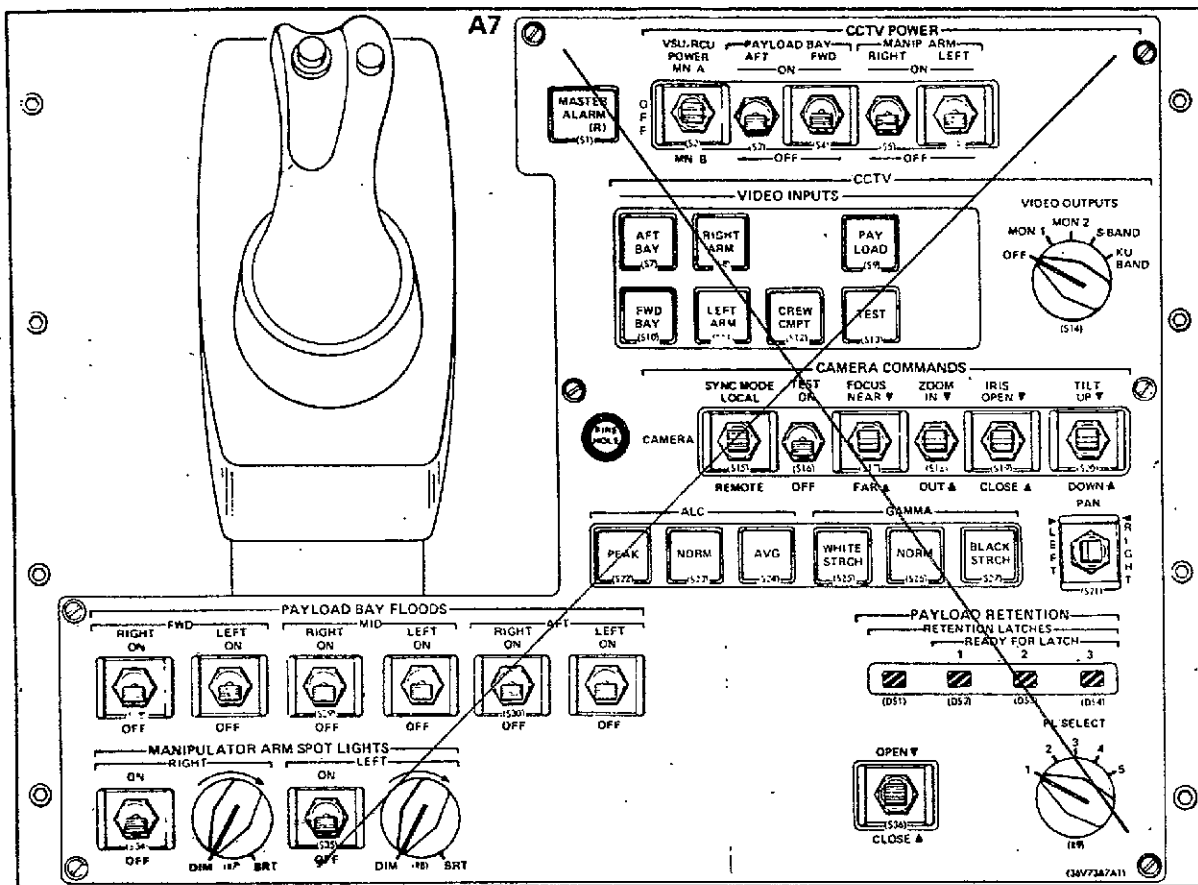
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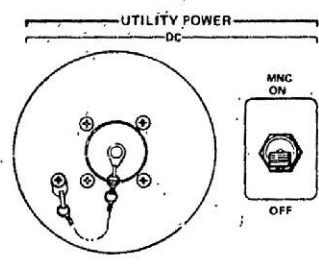
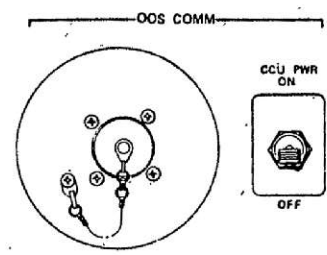
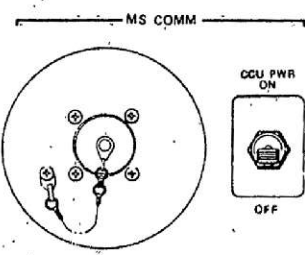
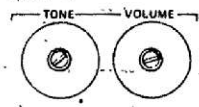
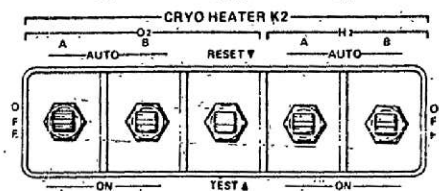
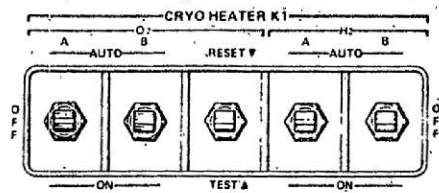
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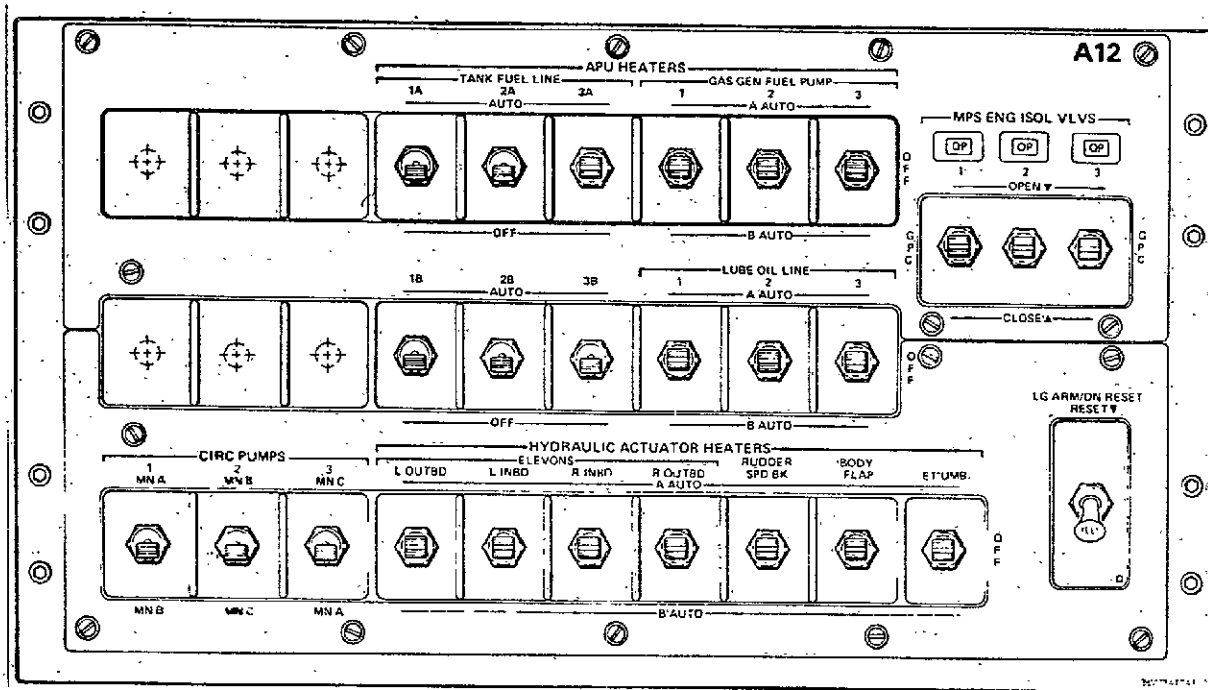
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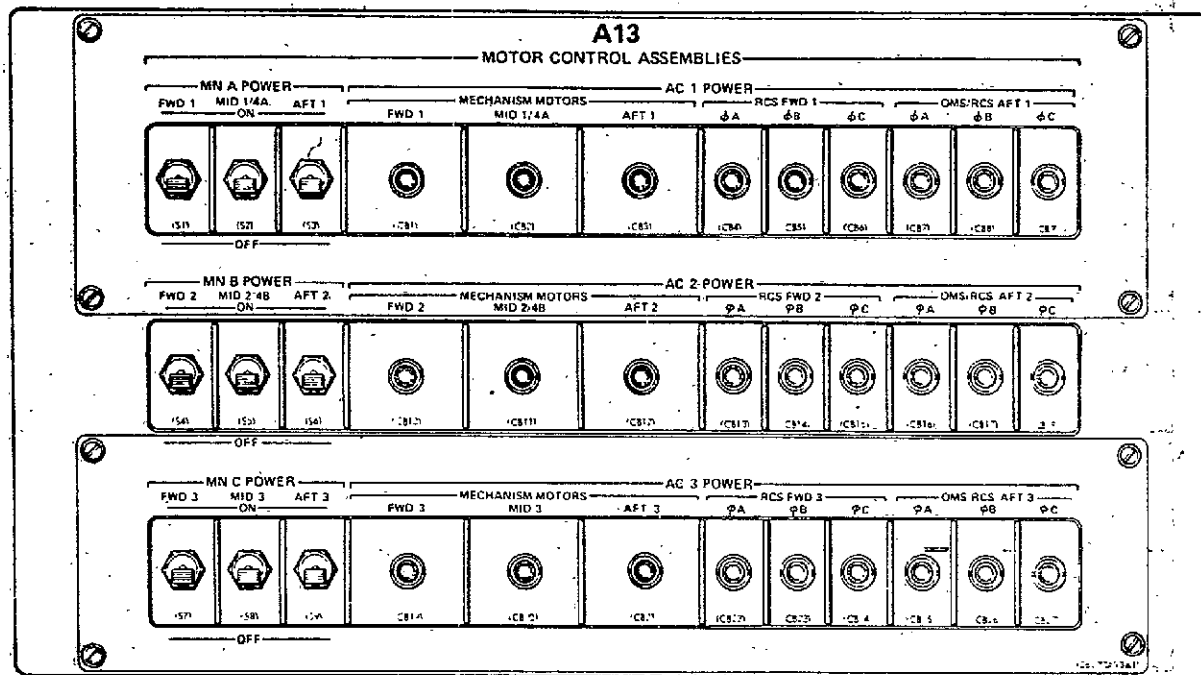


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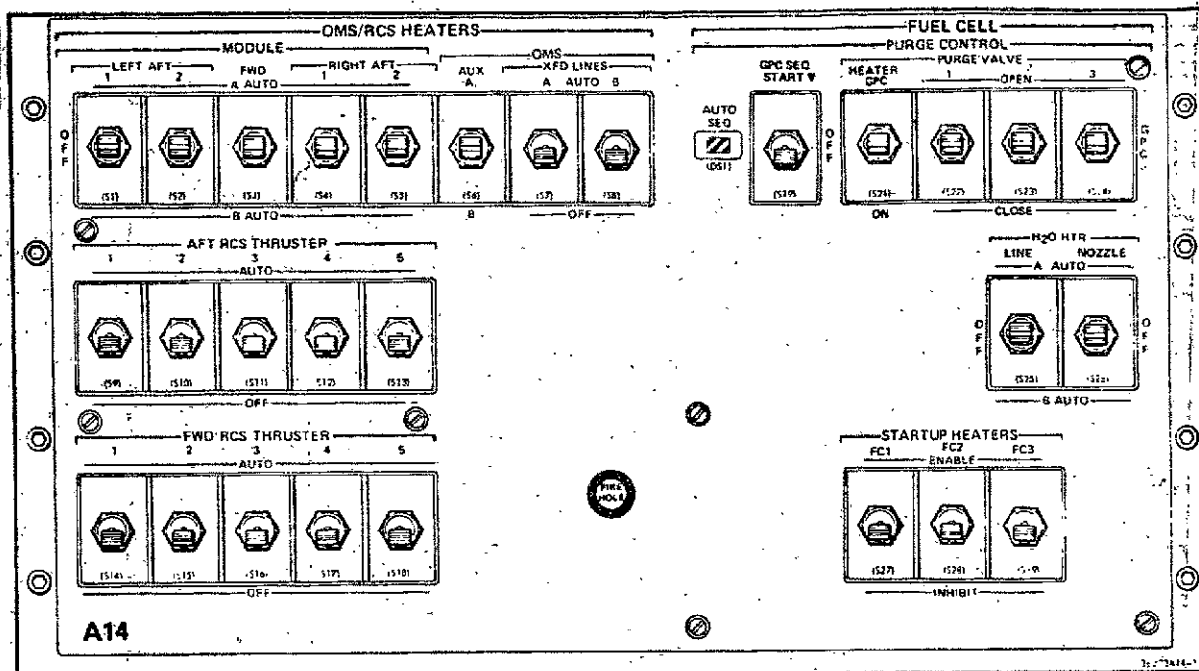


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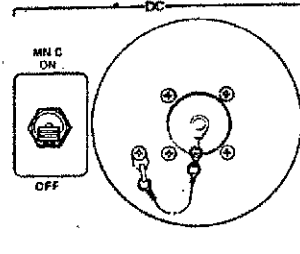
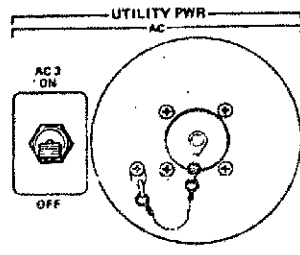
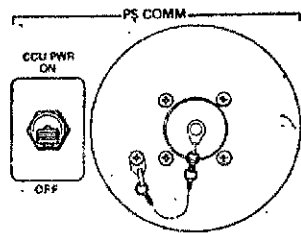
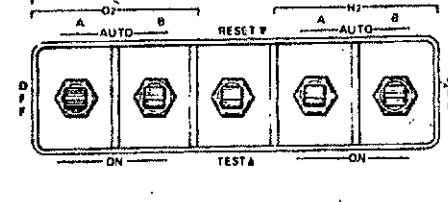
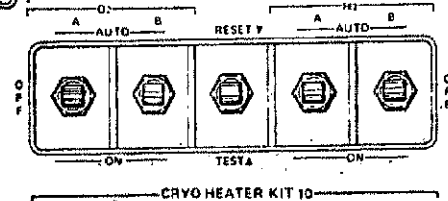
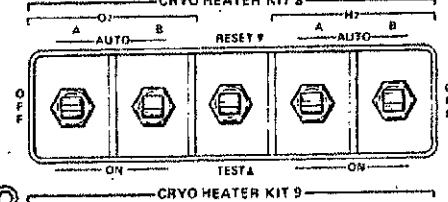
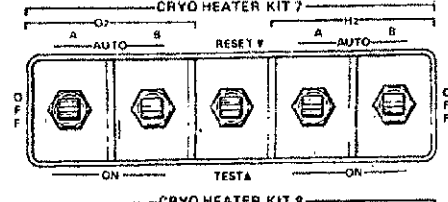
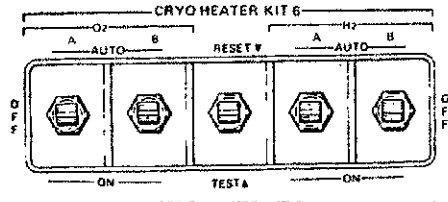
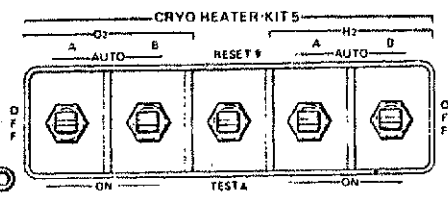
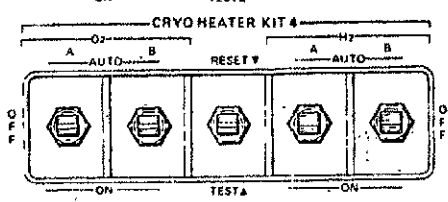
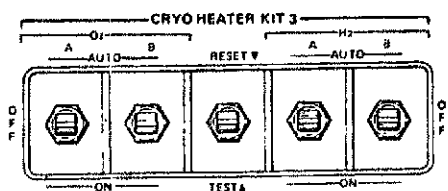
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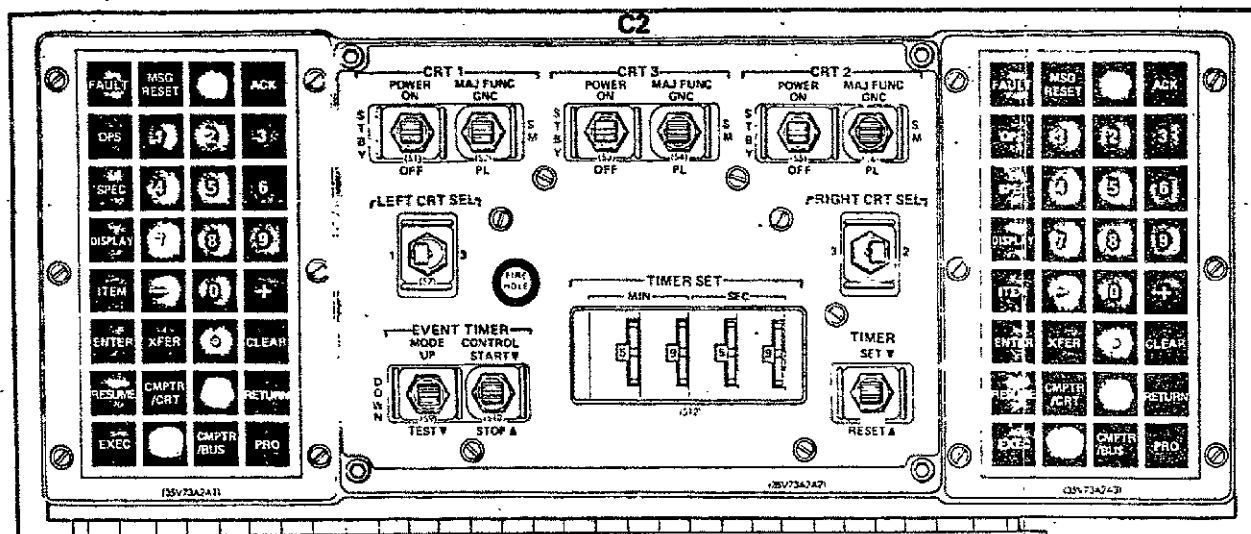
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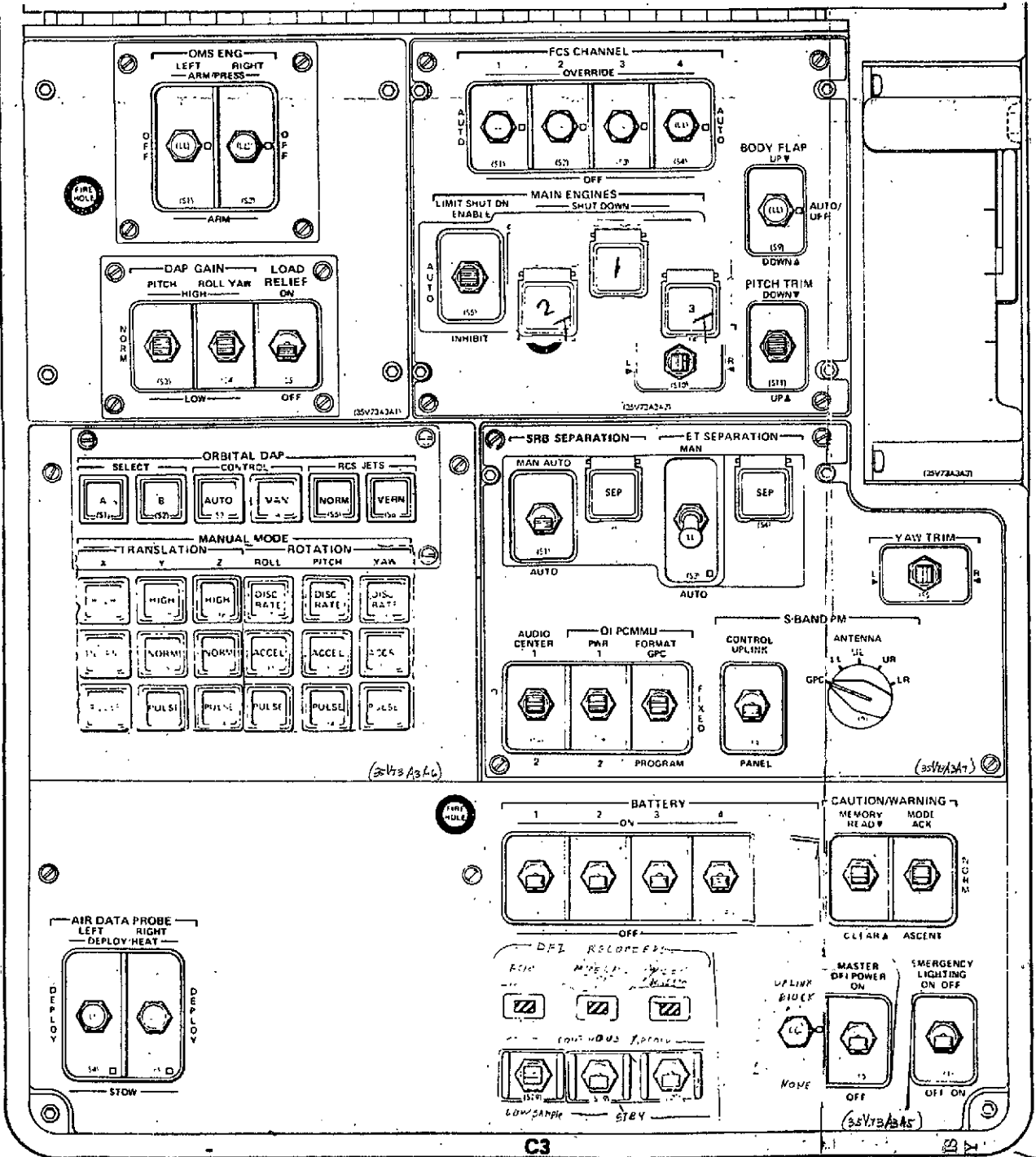
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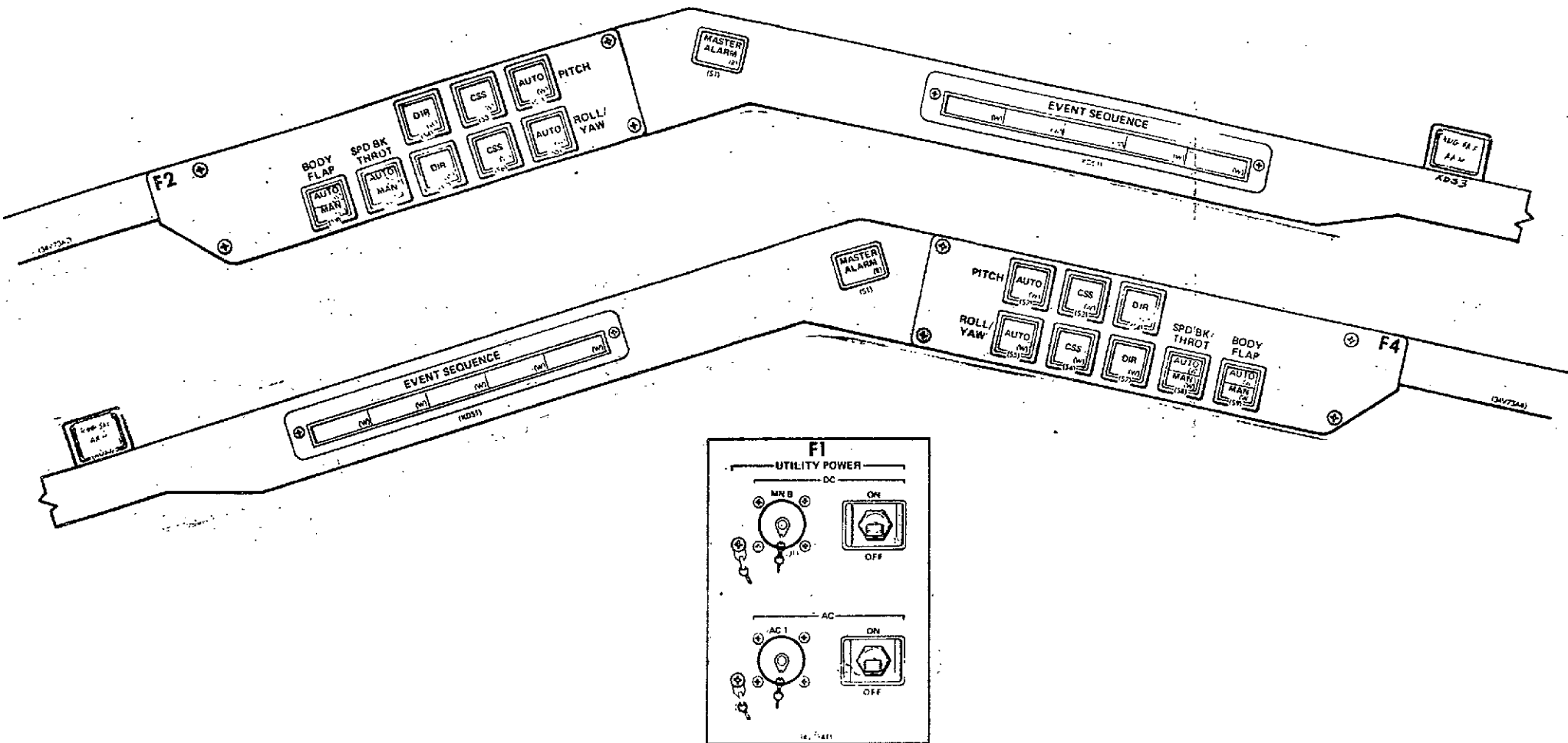
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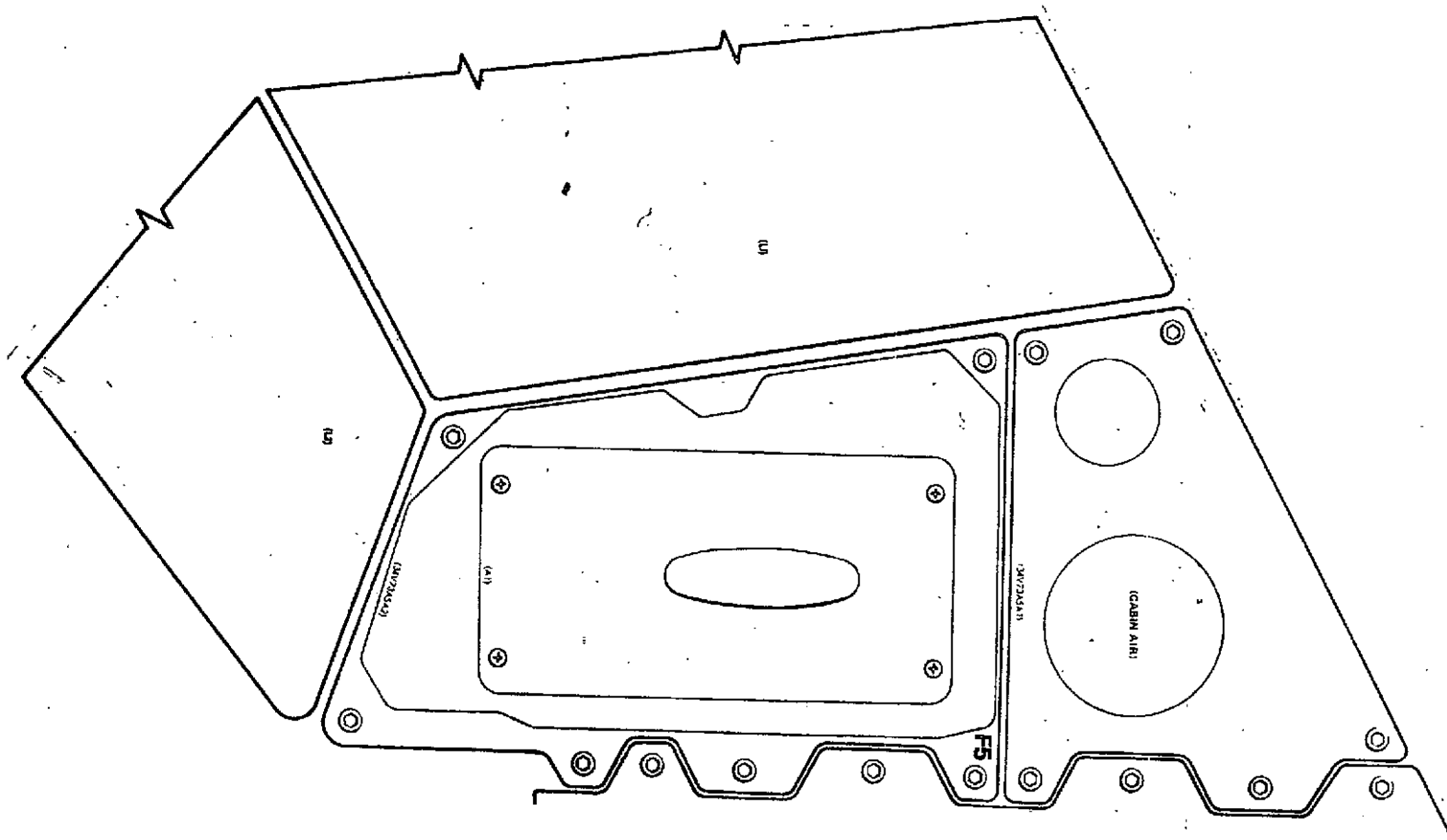
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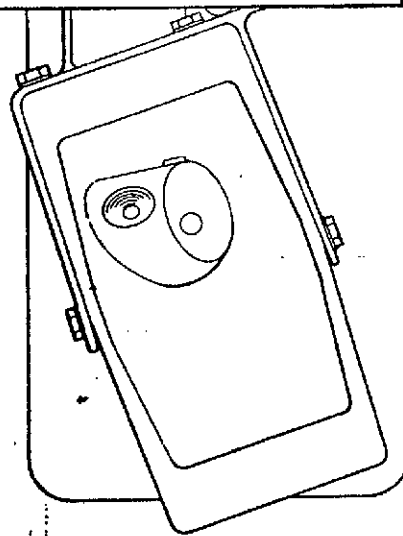
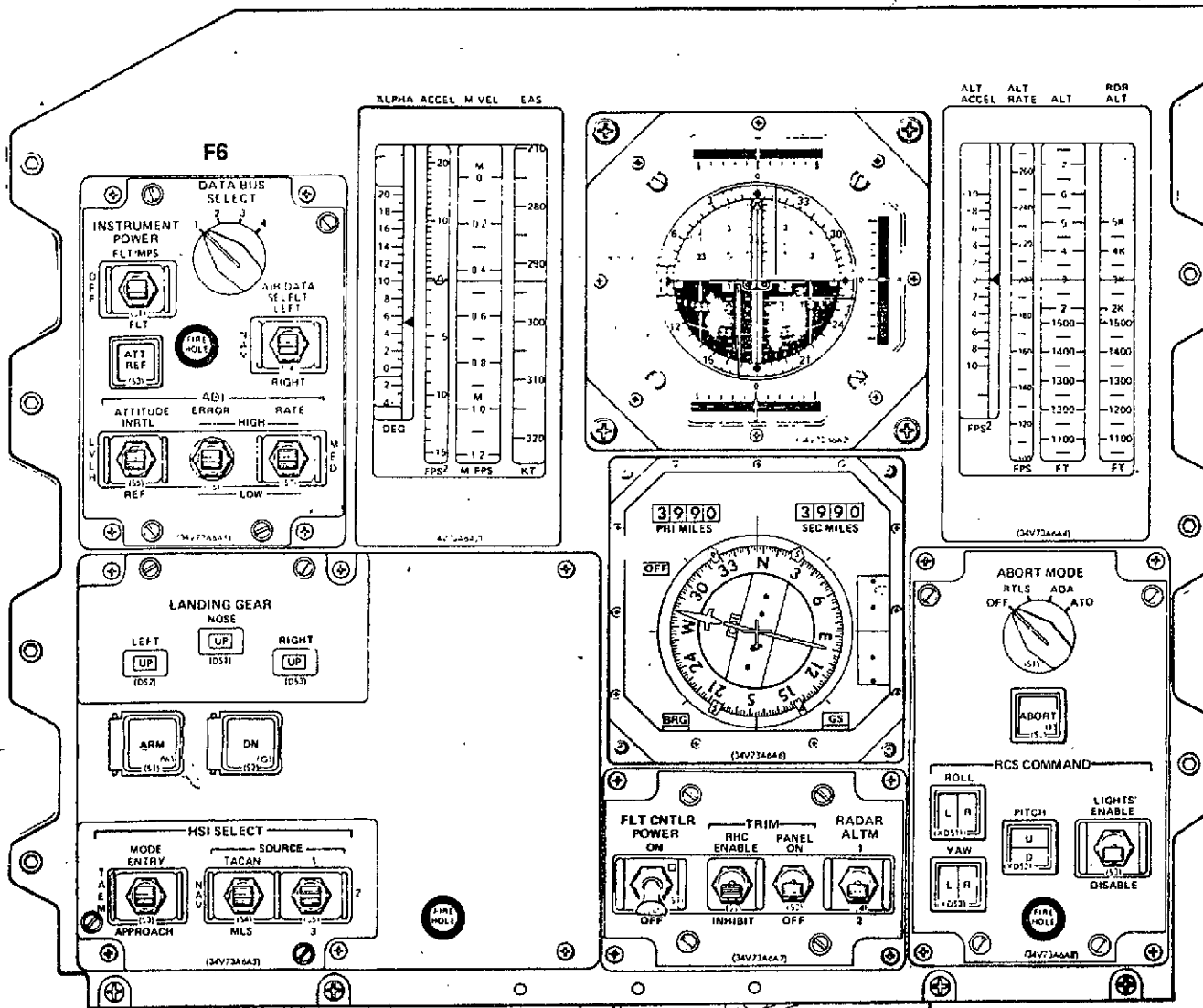
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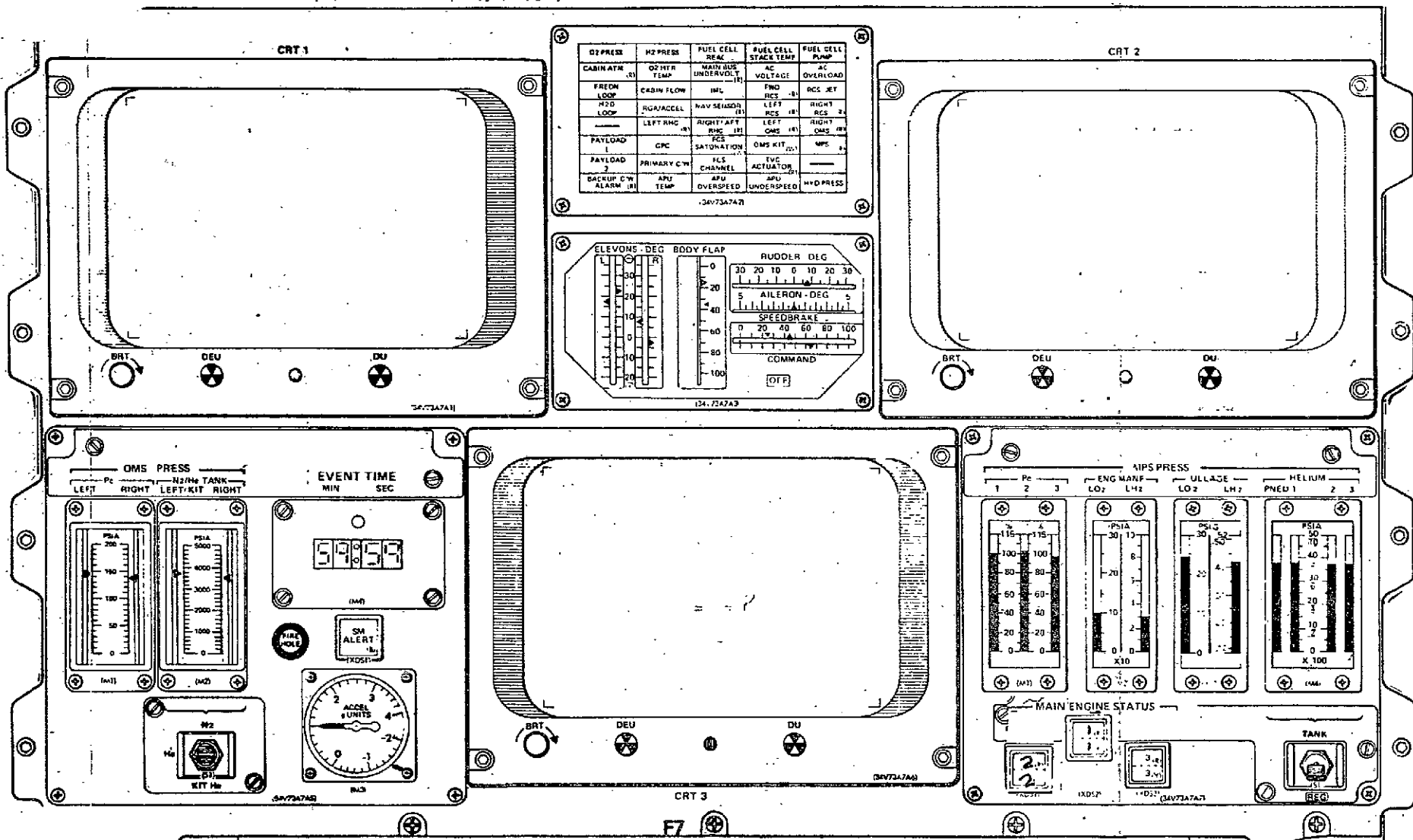


PAL F 5

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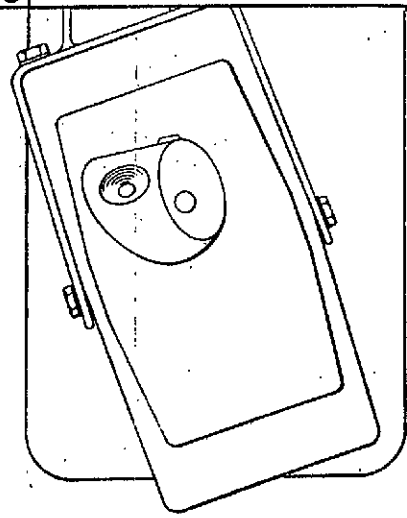
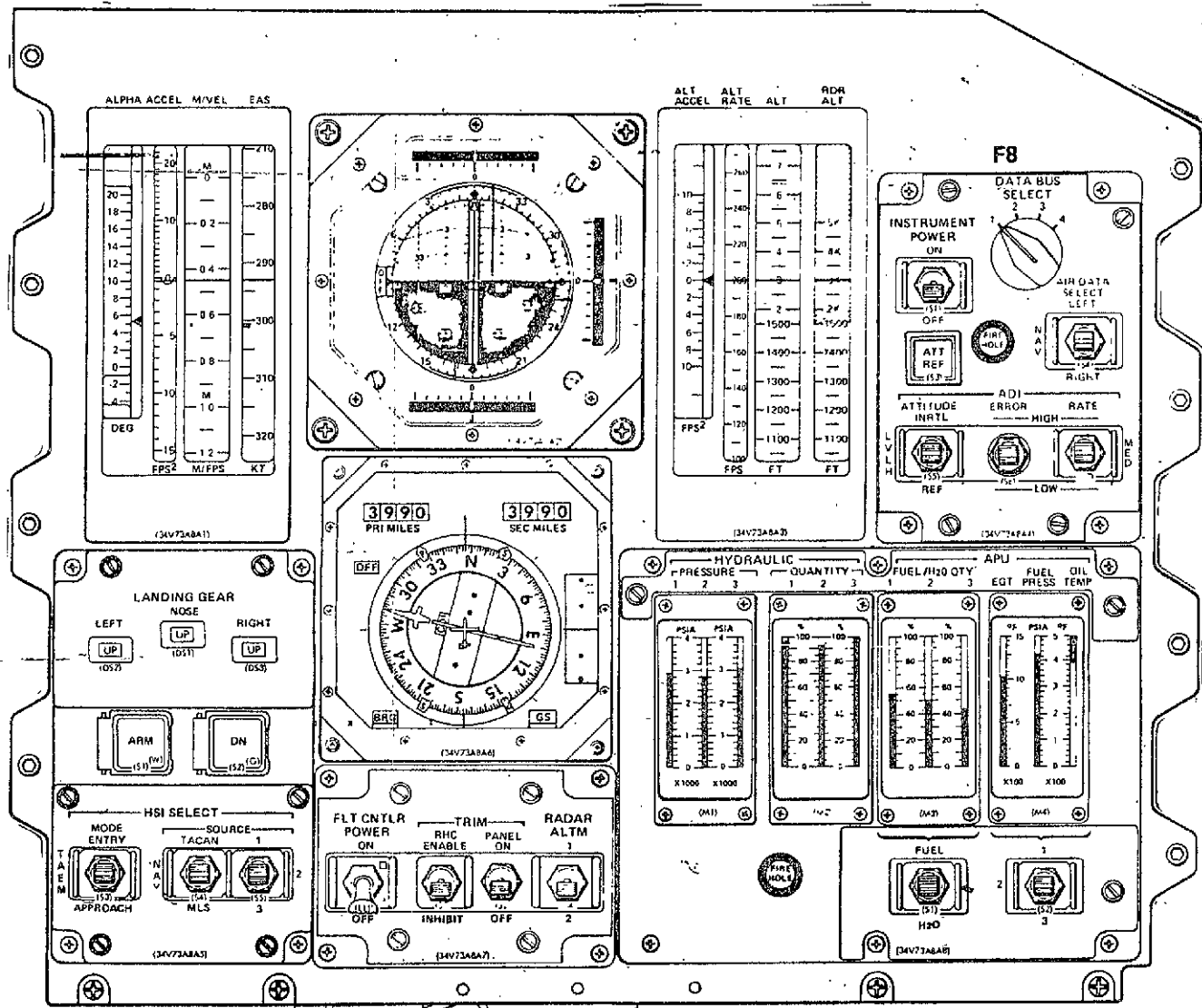
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PULF 7

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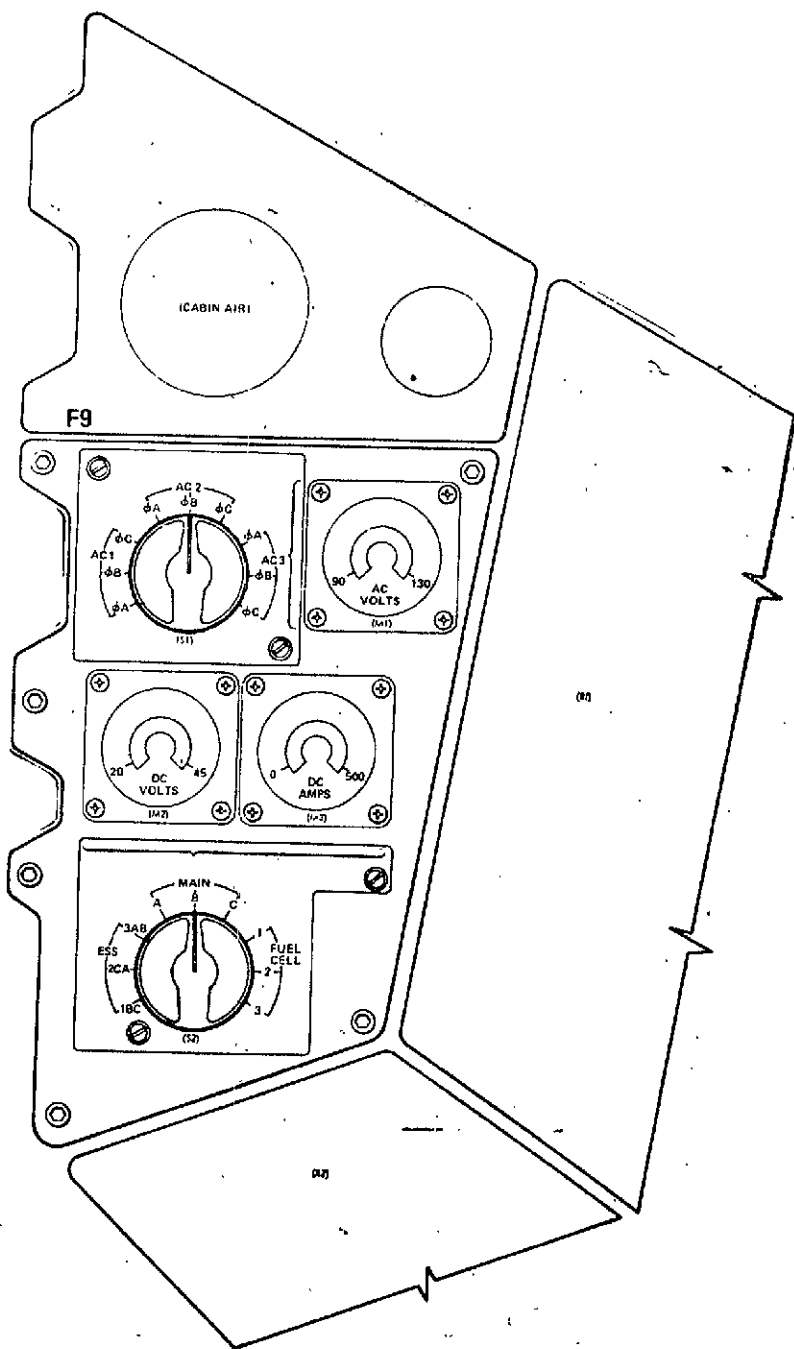


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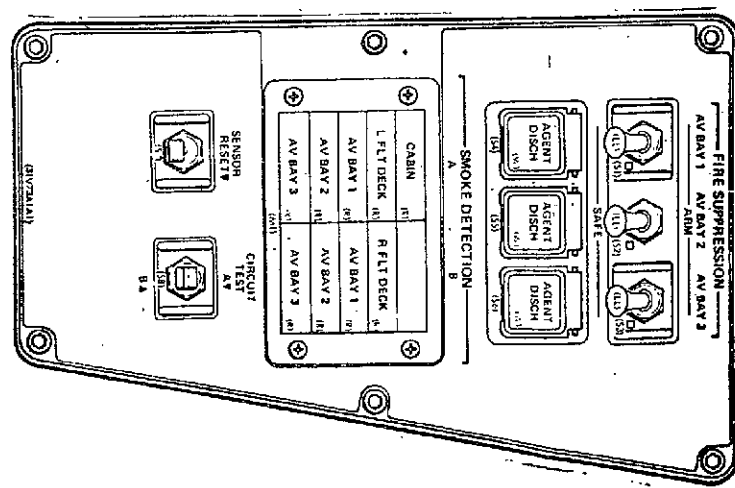
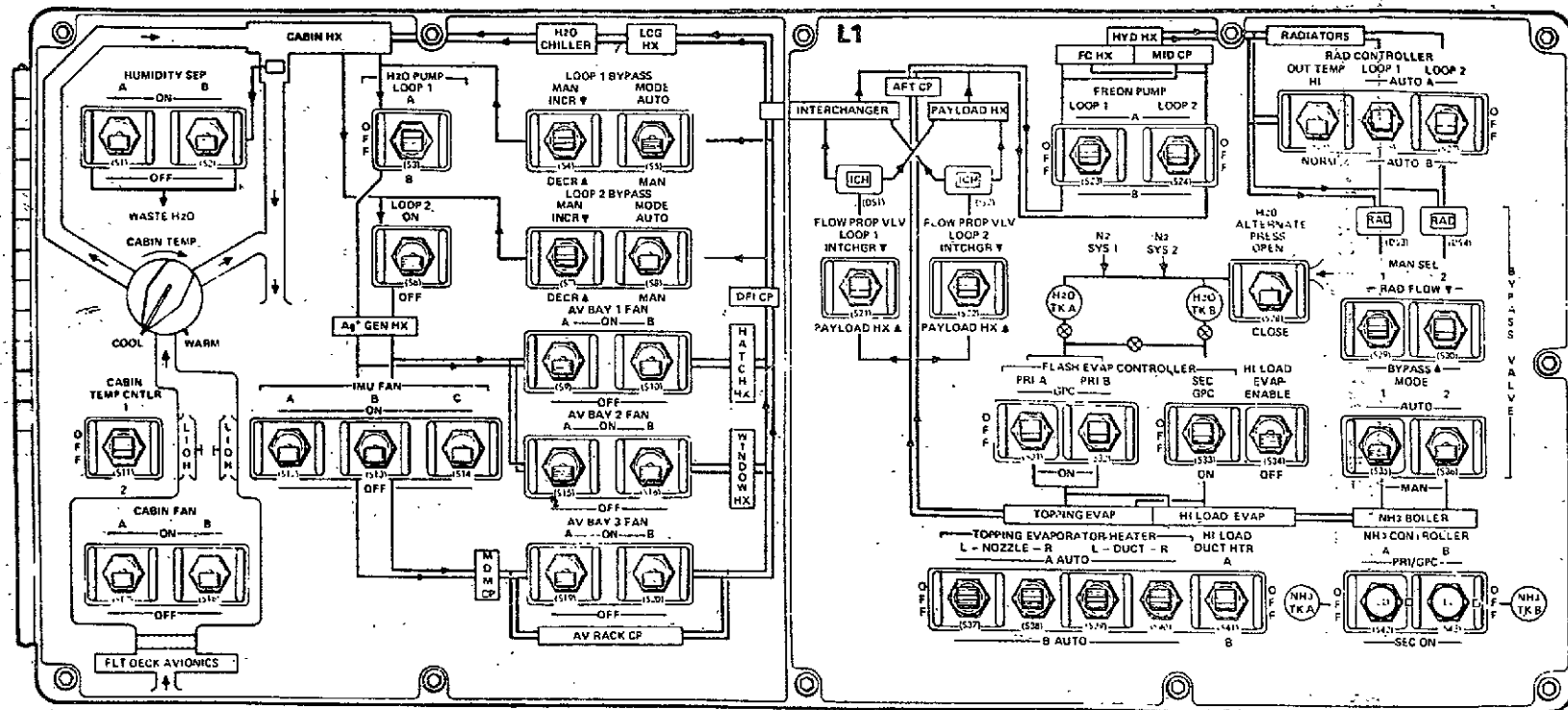
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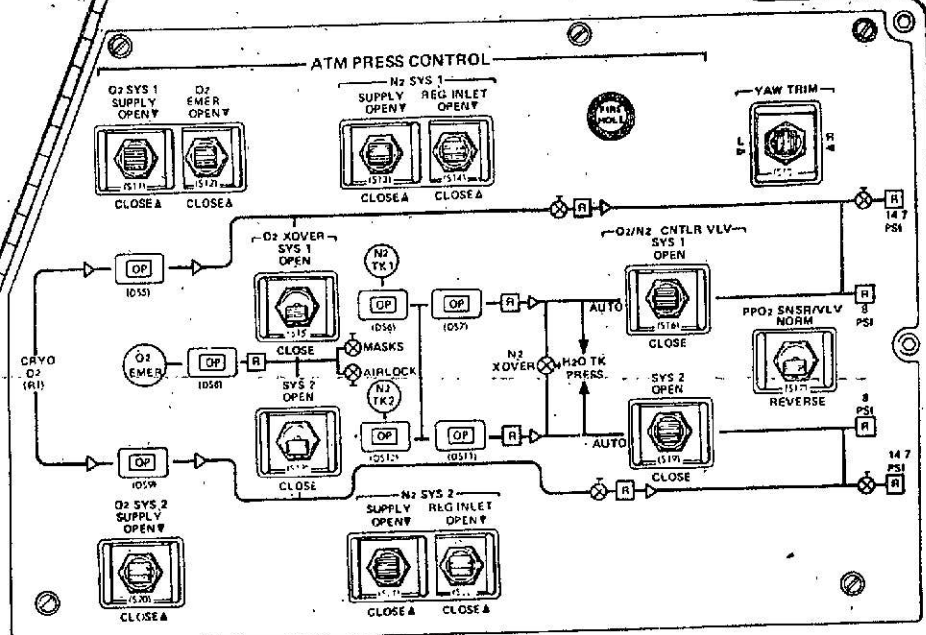
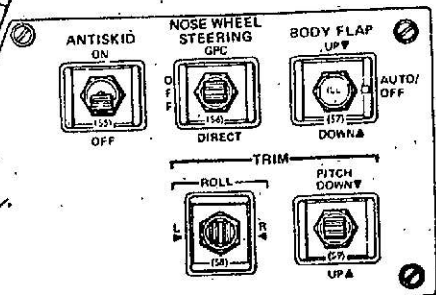
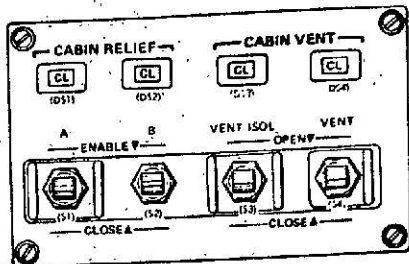
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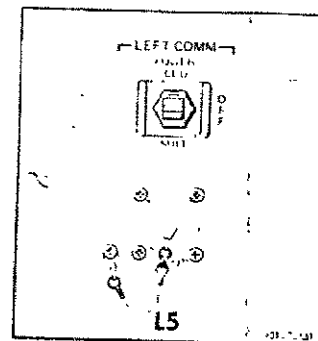
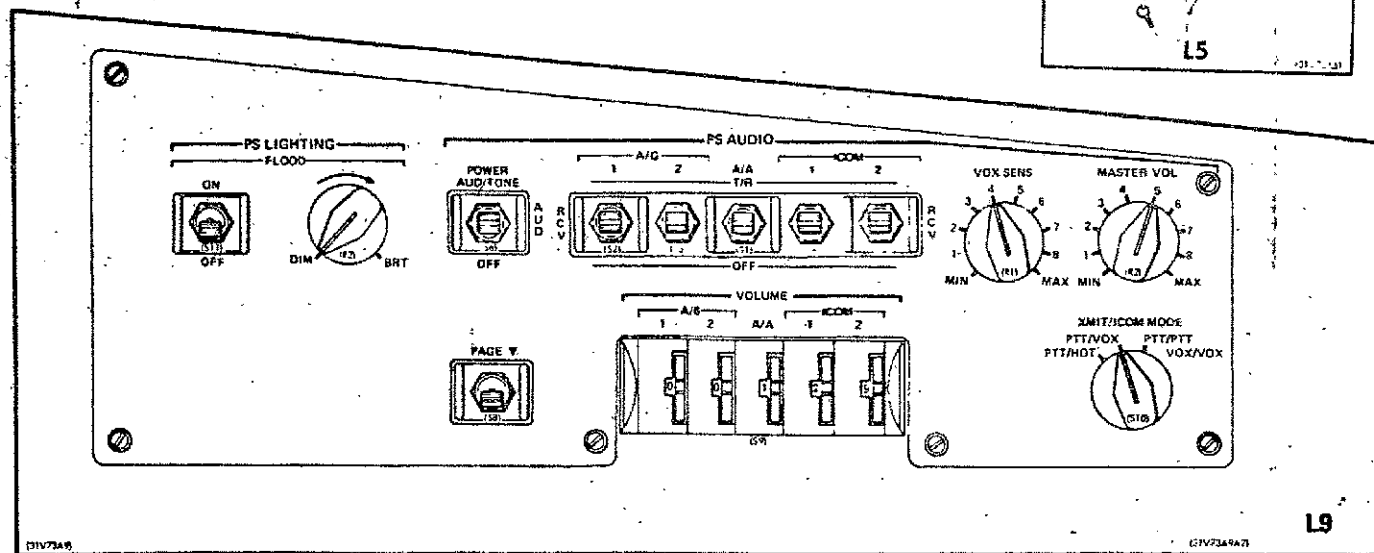
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PWL L2



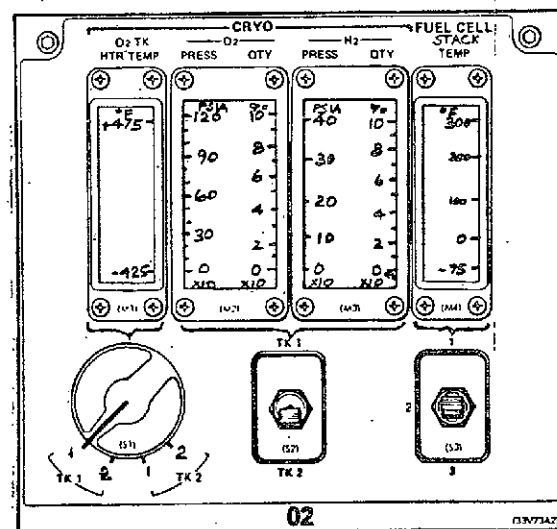
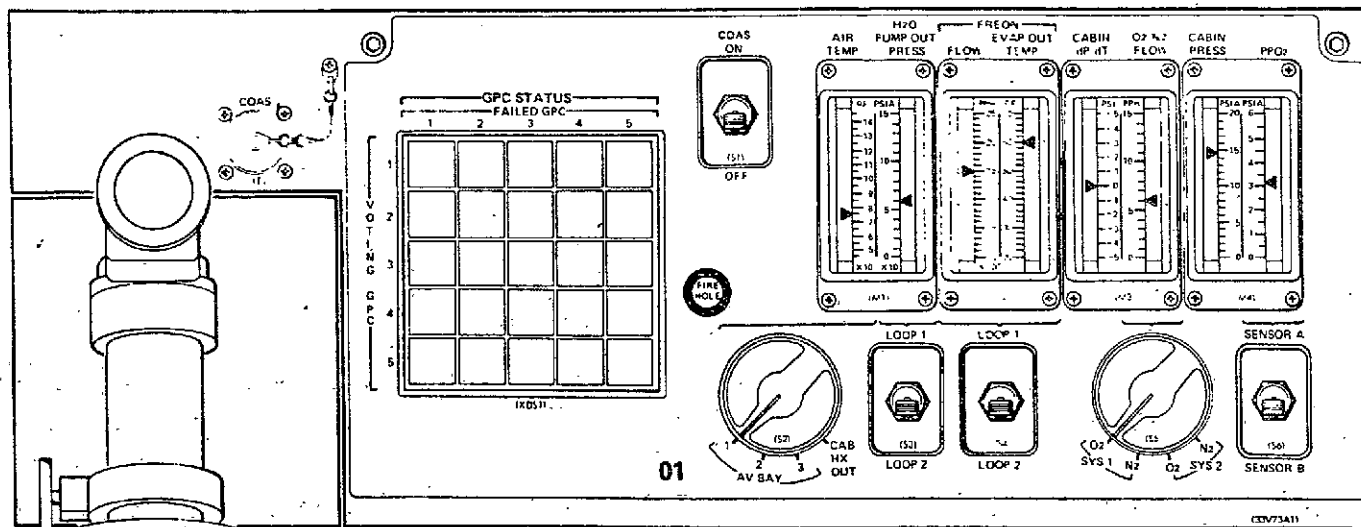


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L9

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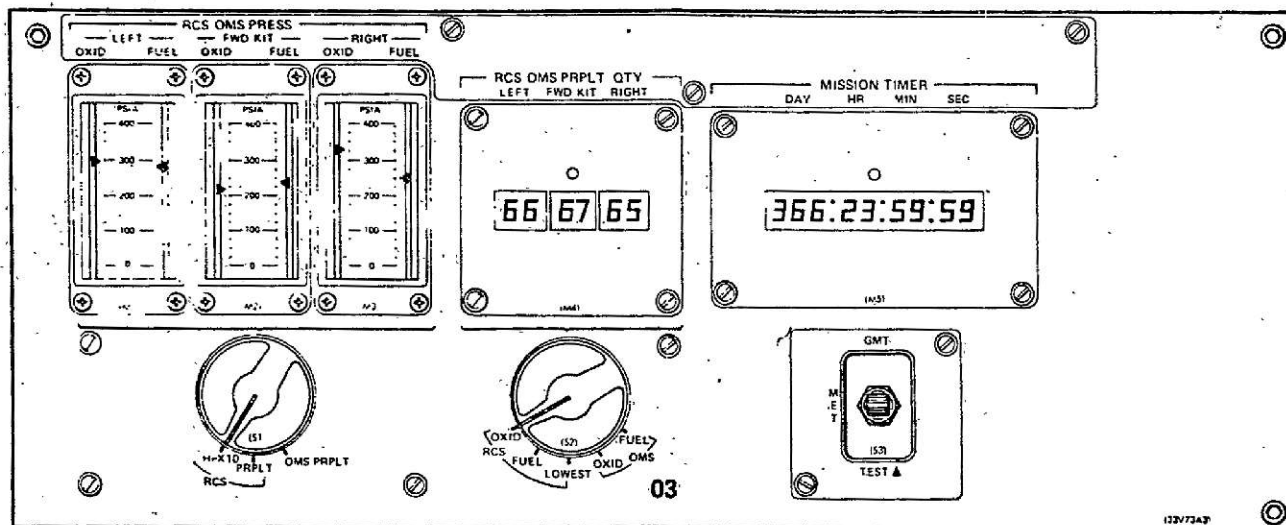


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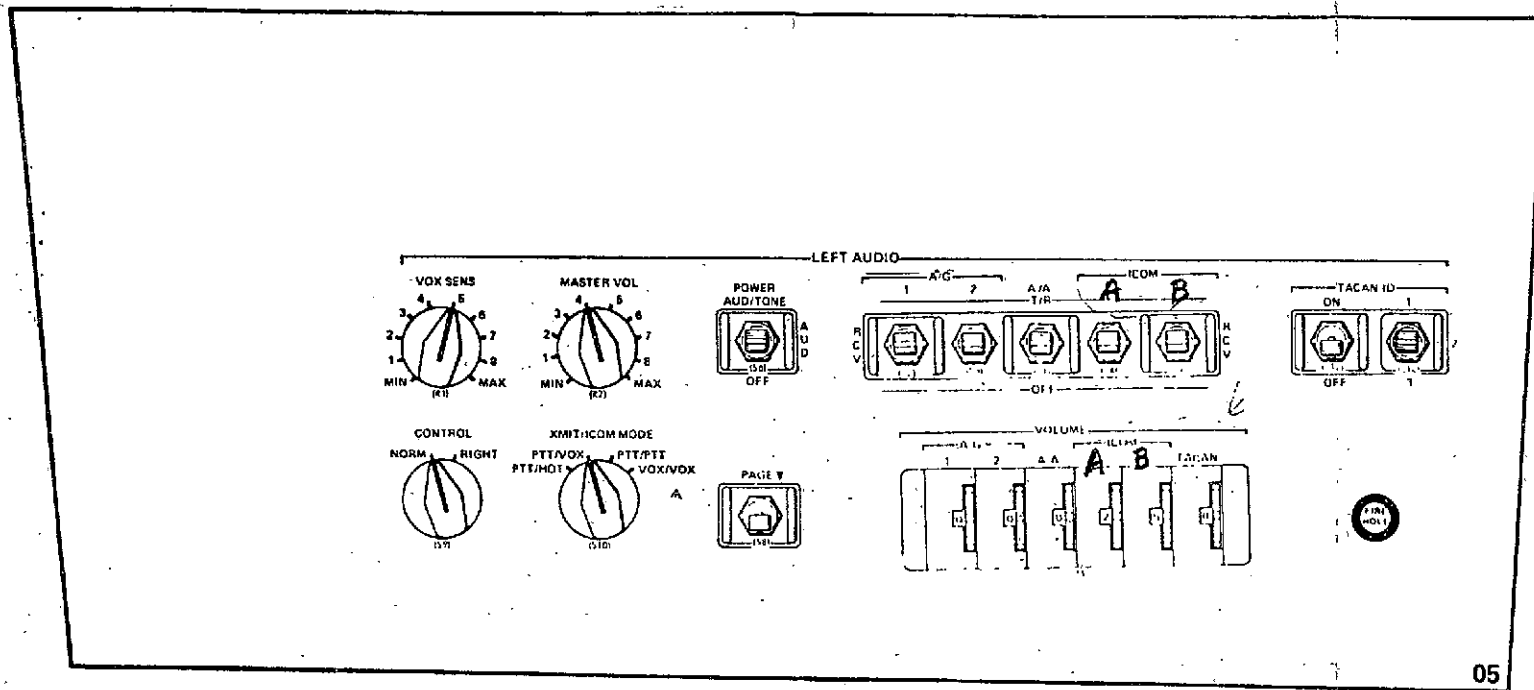
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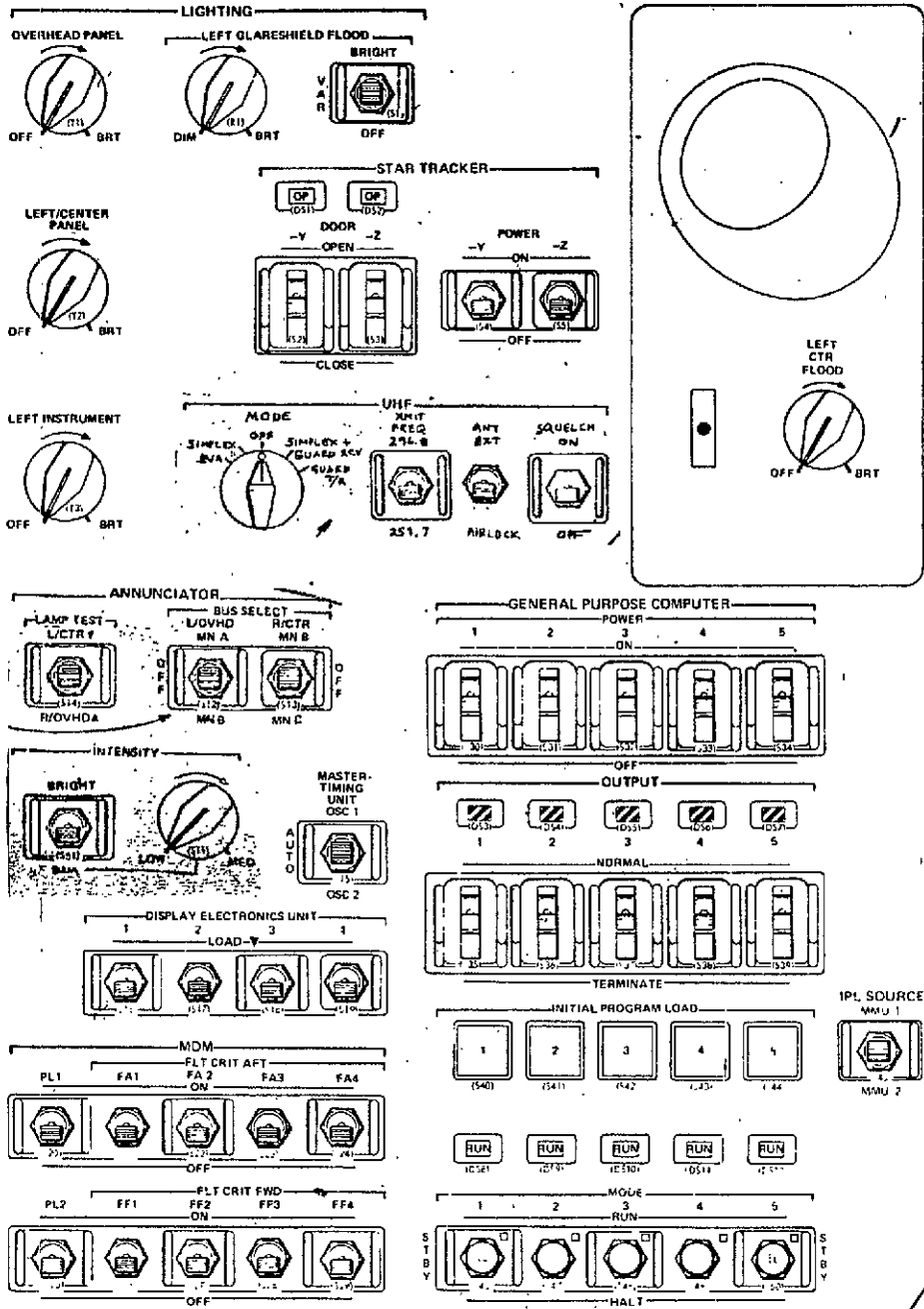
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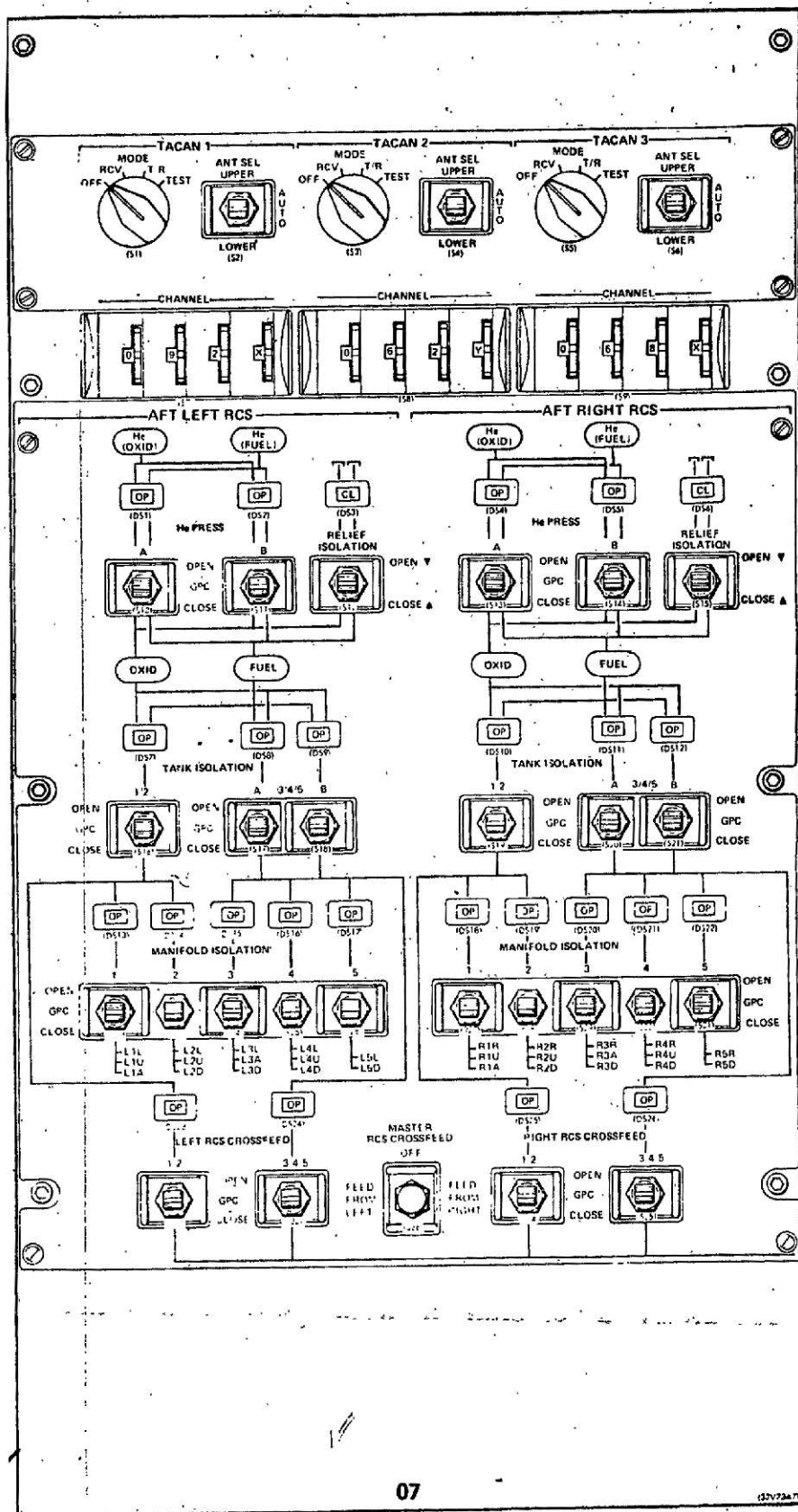
FOOTNOTES



FOOTNOTES  
PWL 06



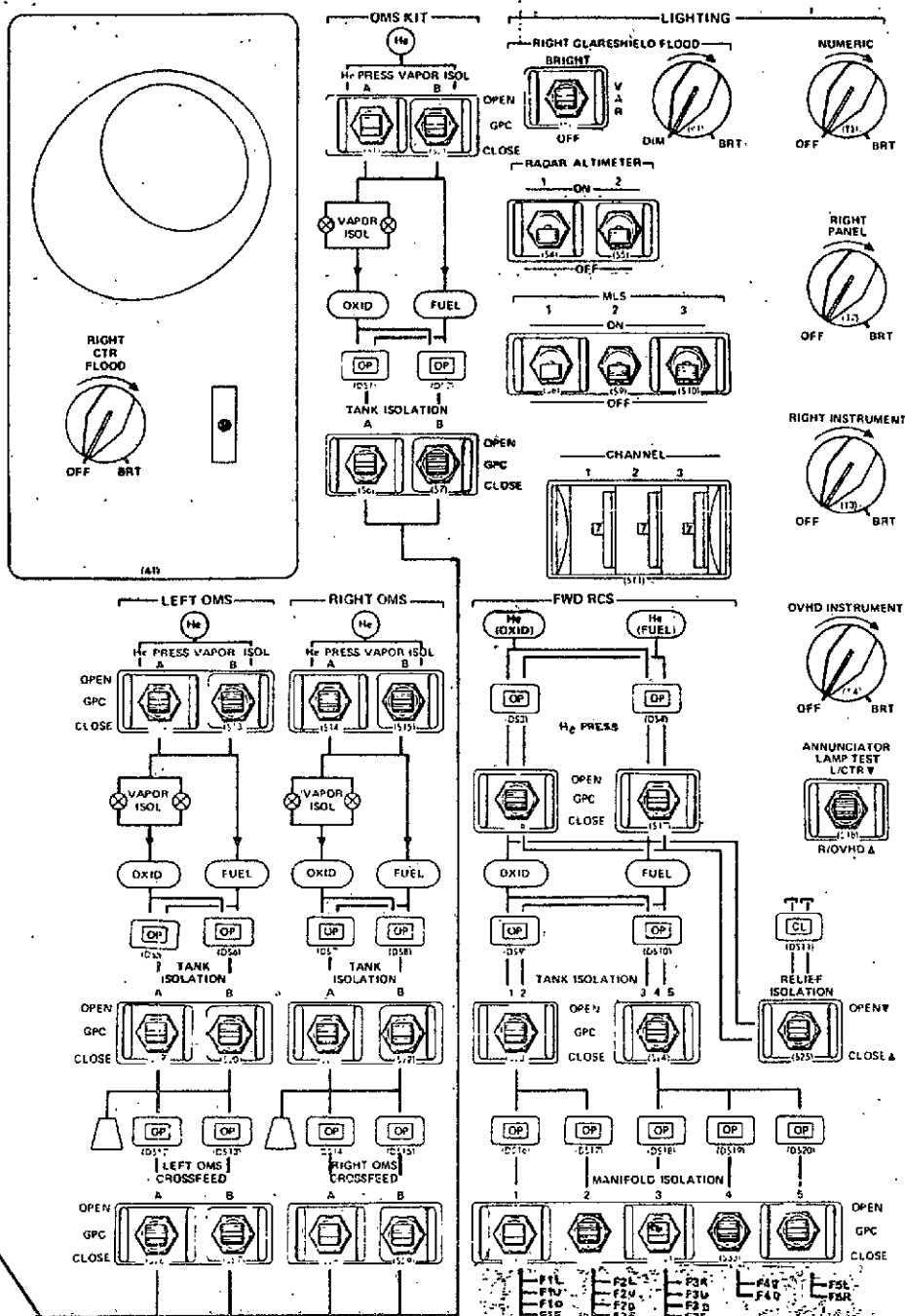
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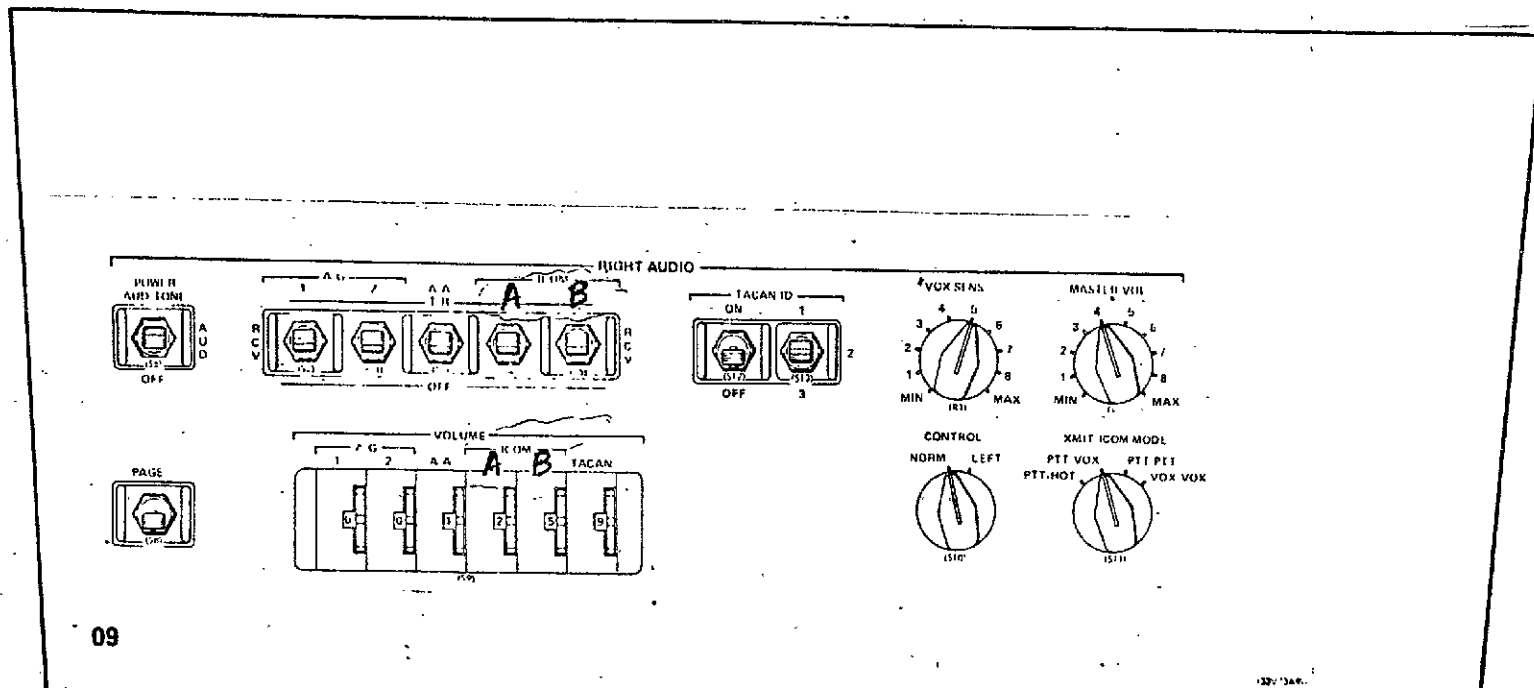


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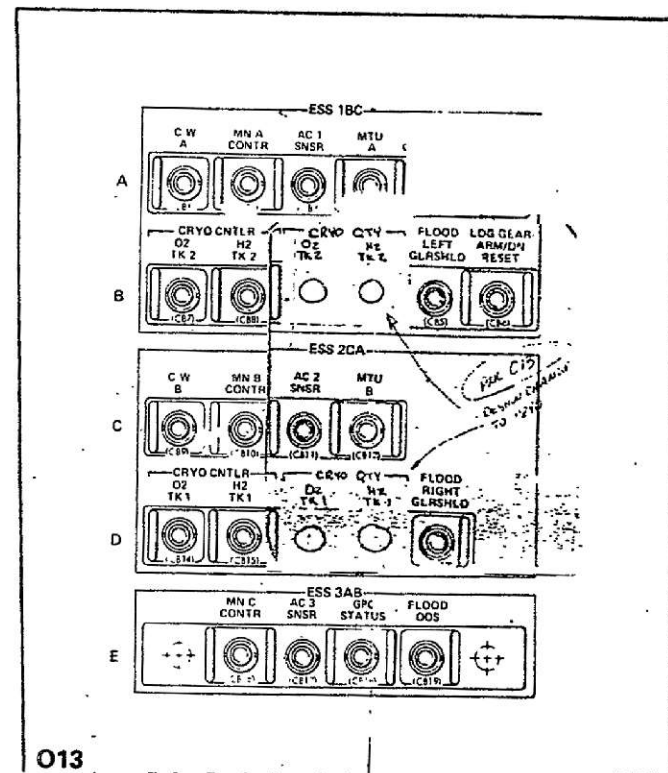
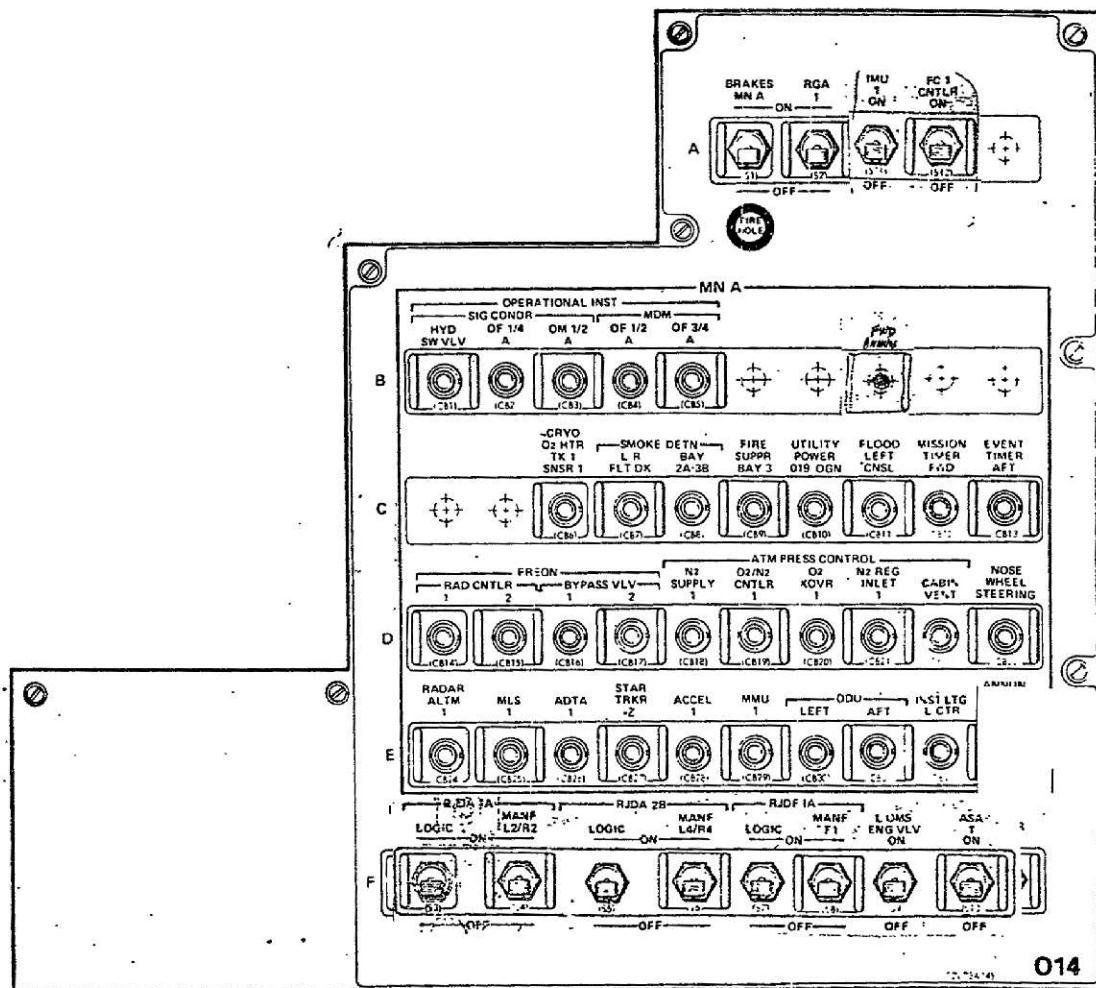
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PNL 09

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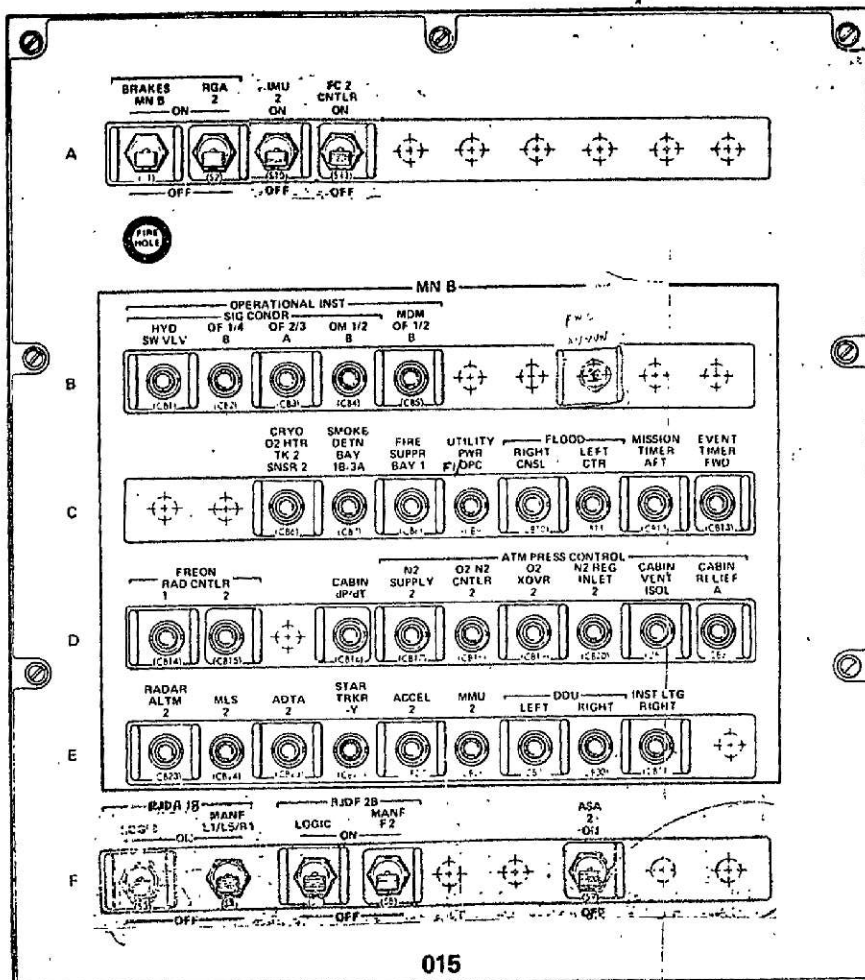
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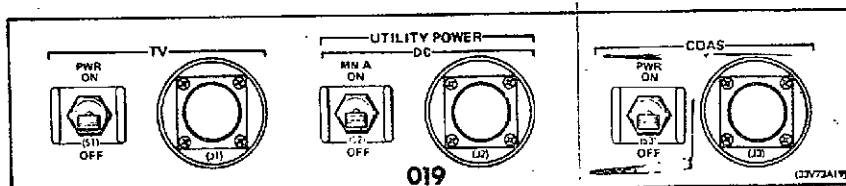
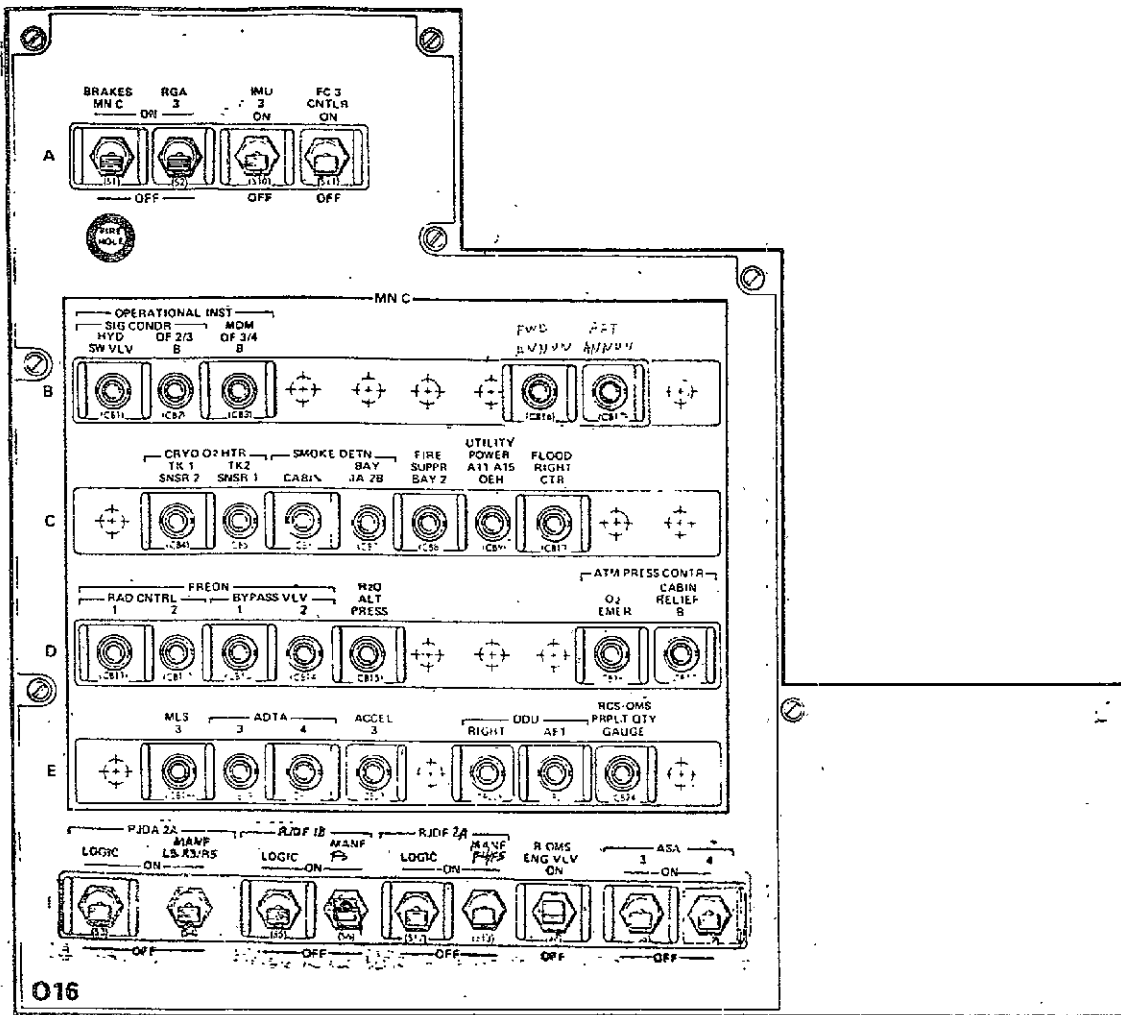
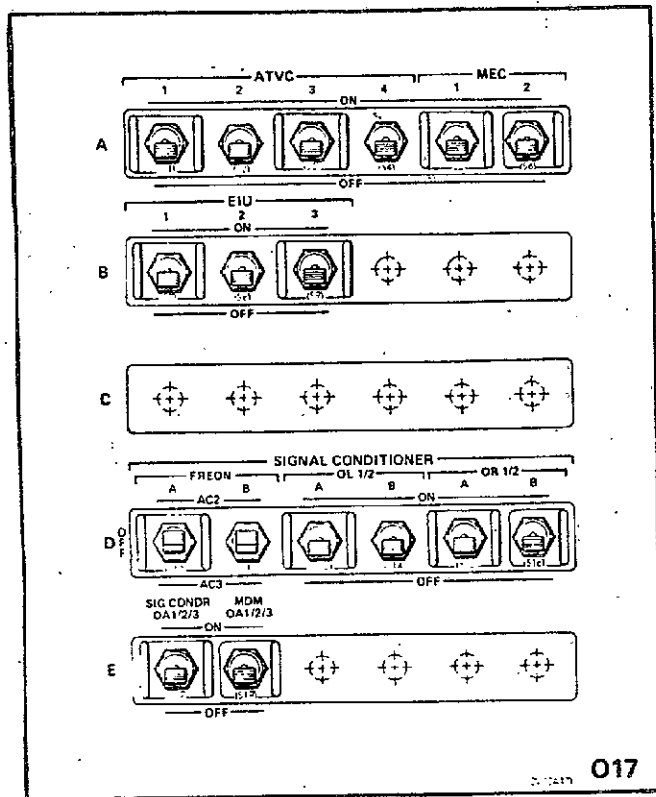
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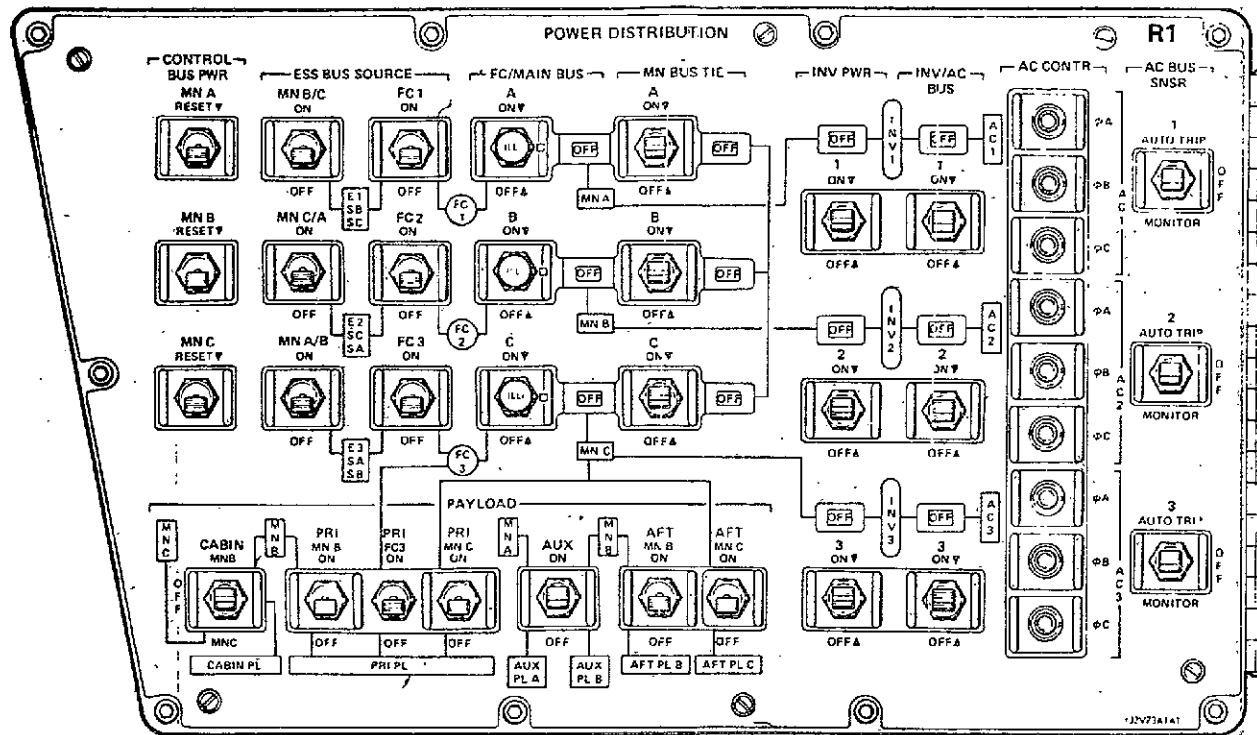
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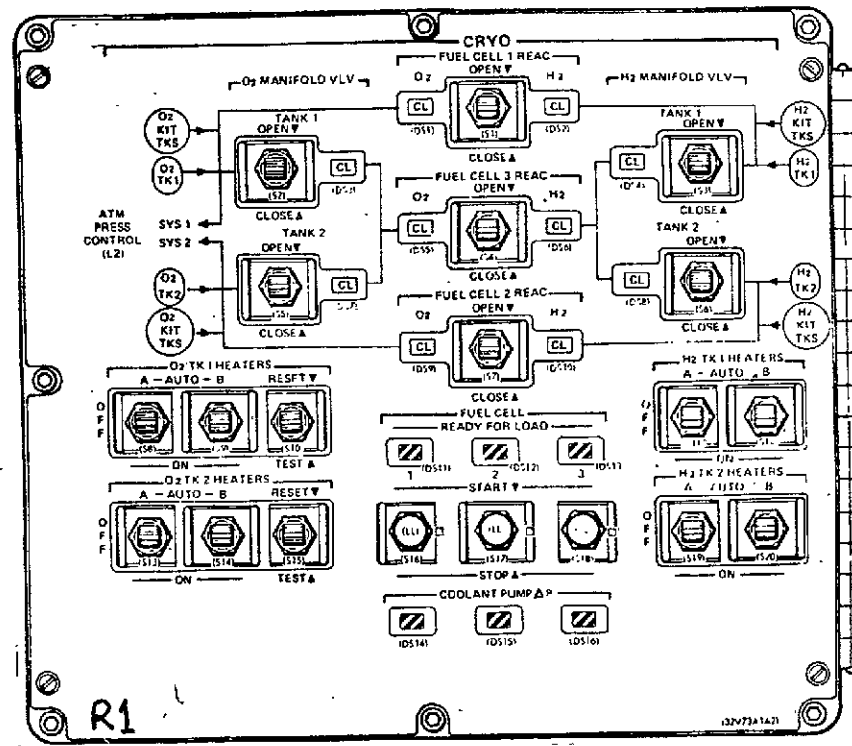
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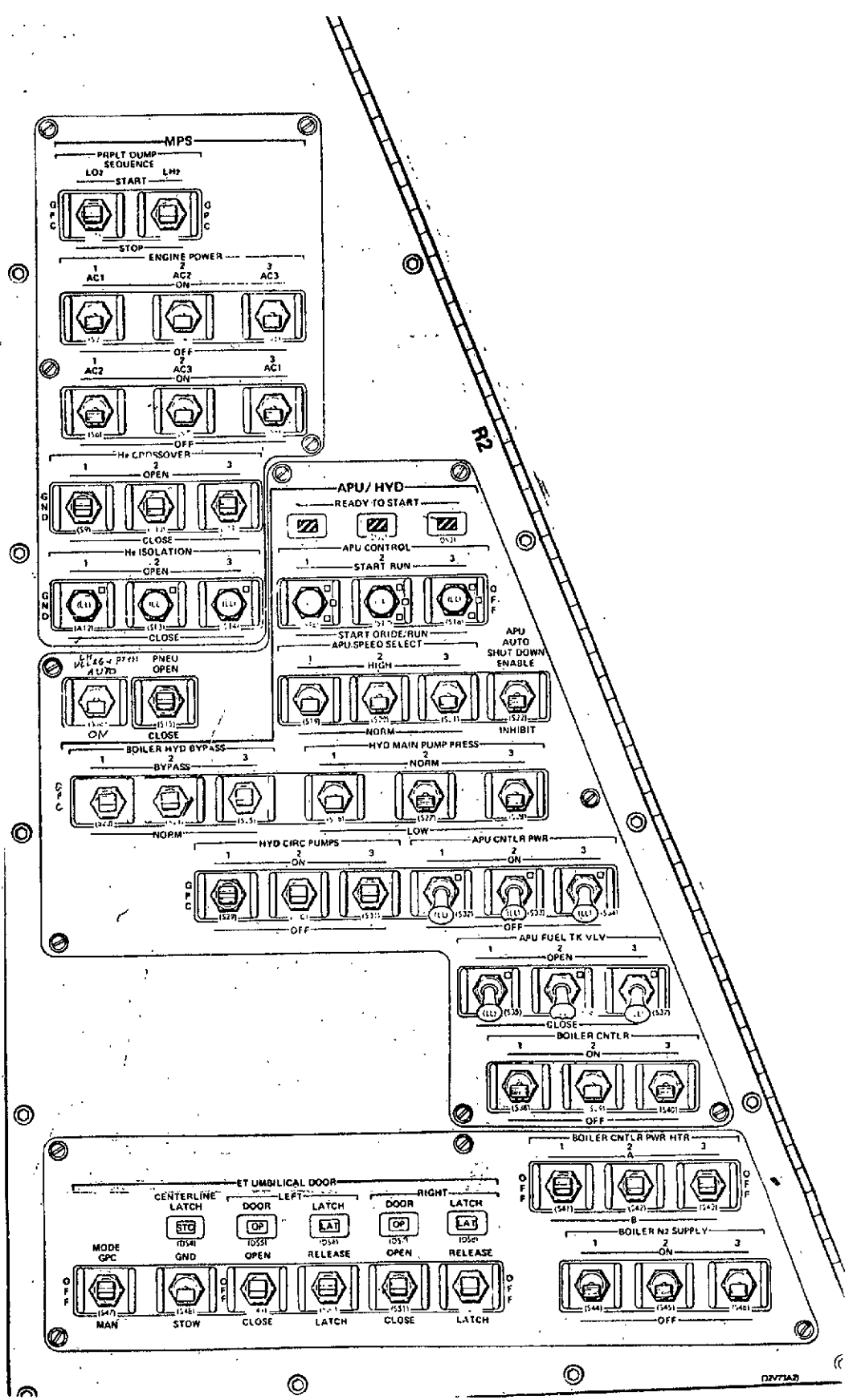
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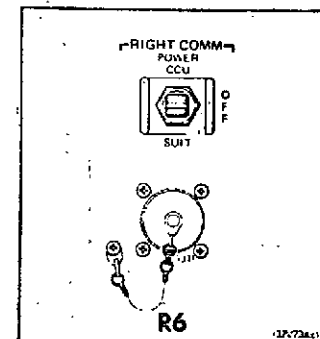
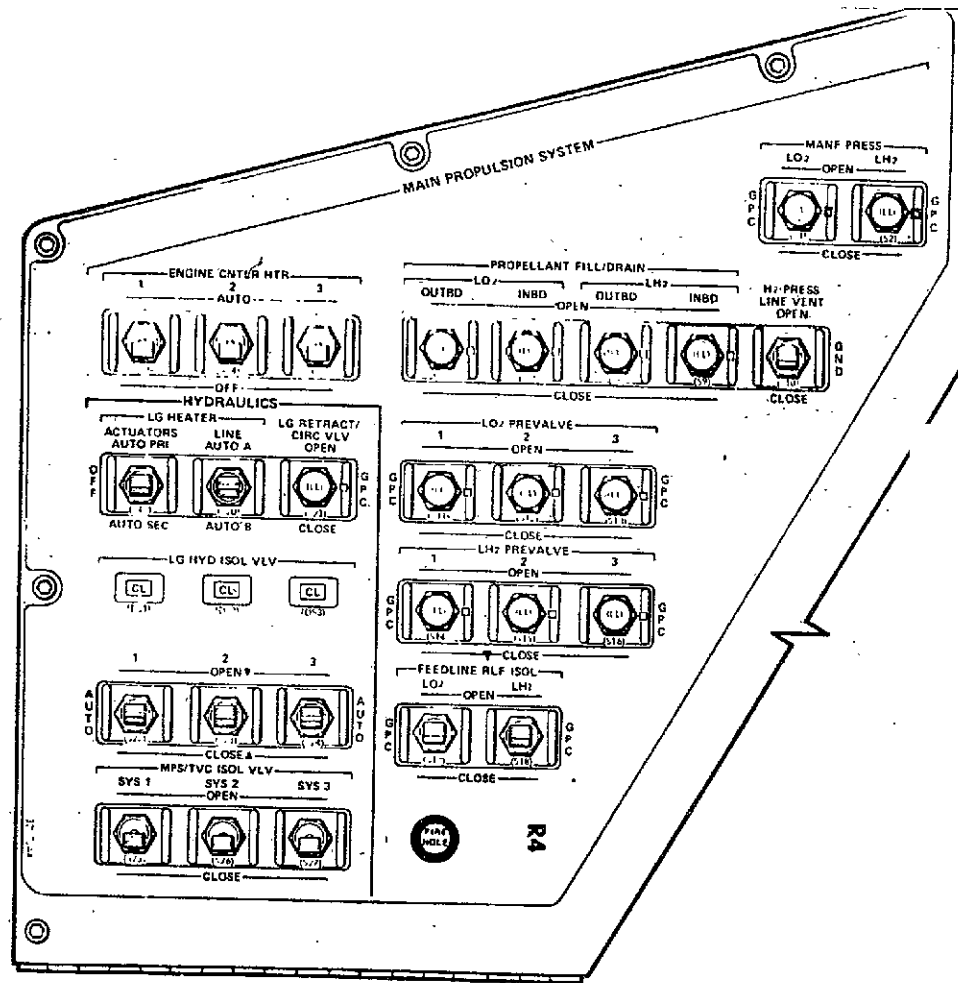
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PUL R2

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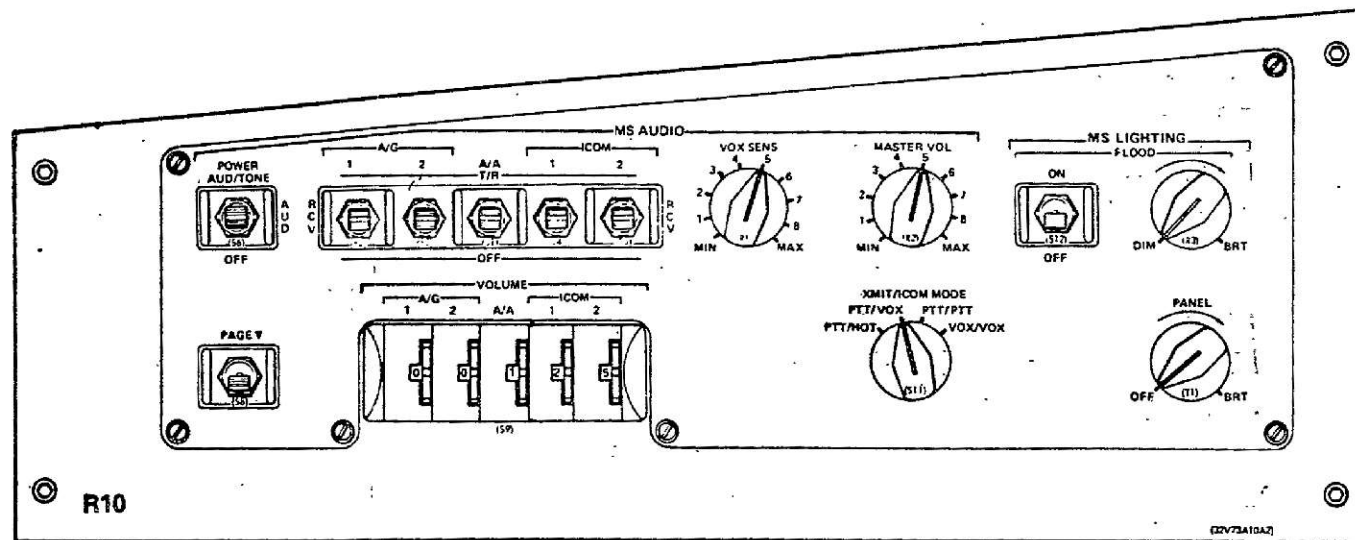
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RNL R4  
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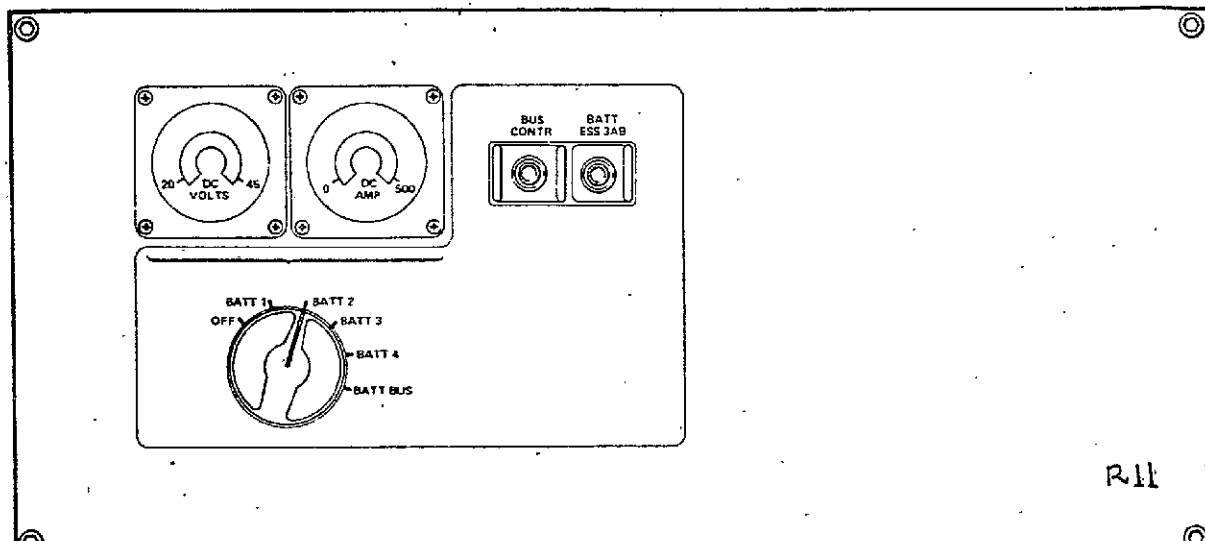


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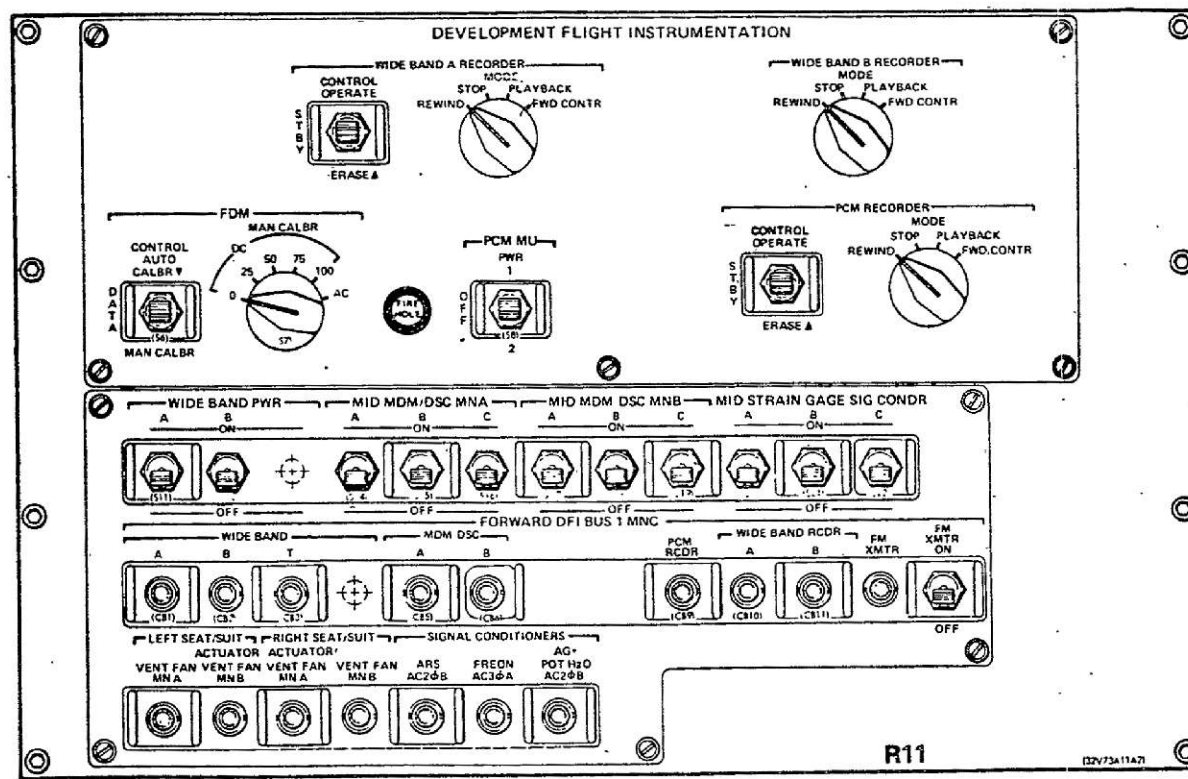


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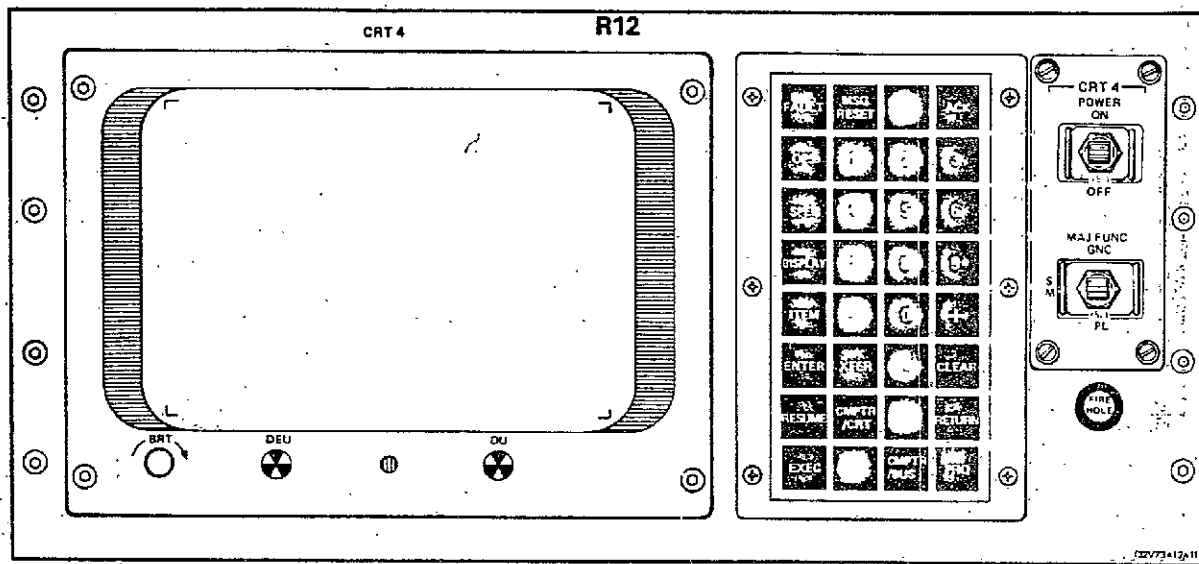


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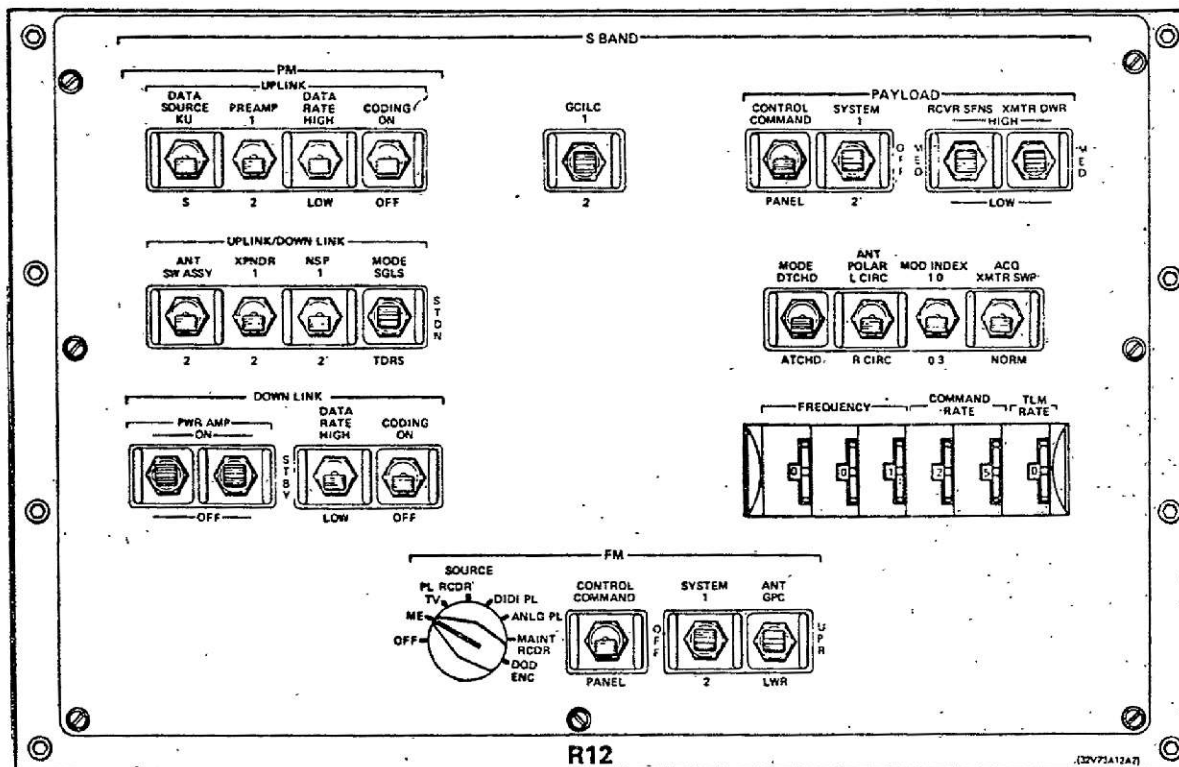
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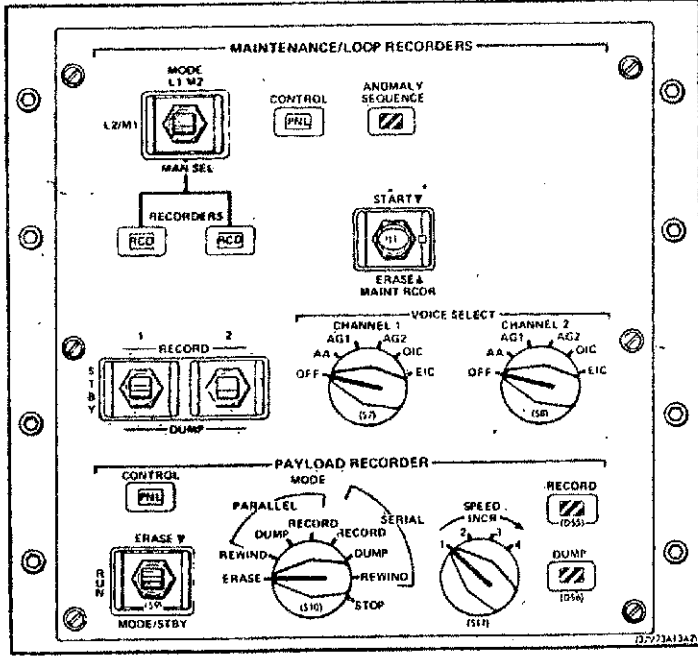
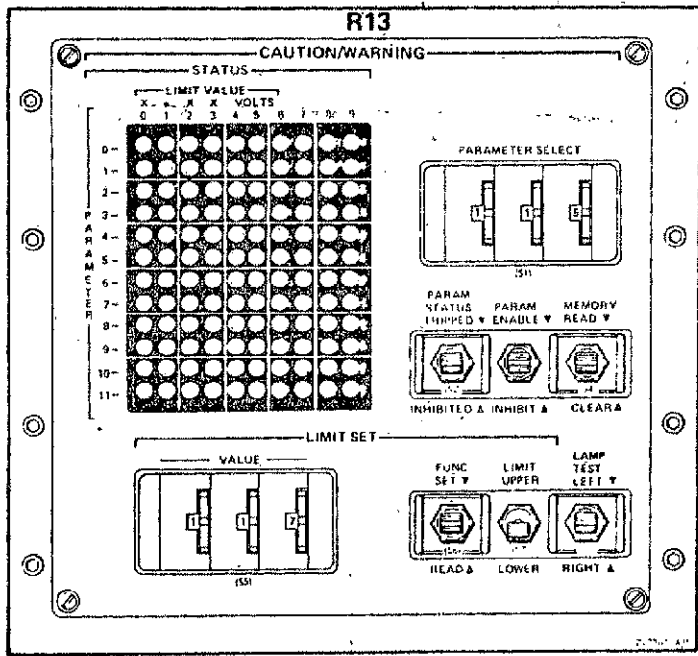
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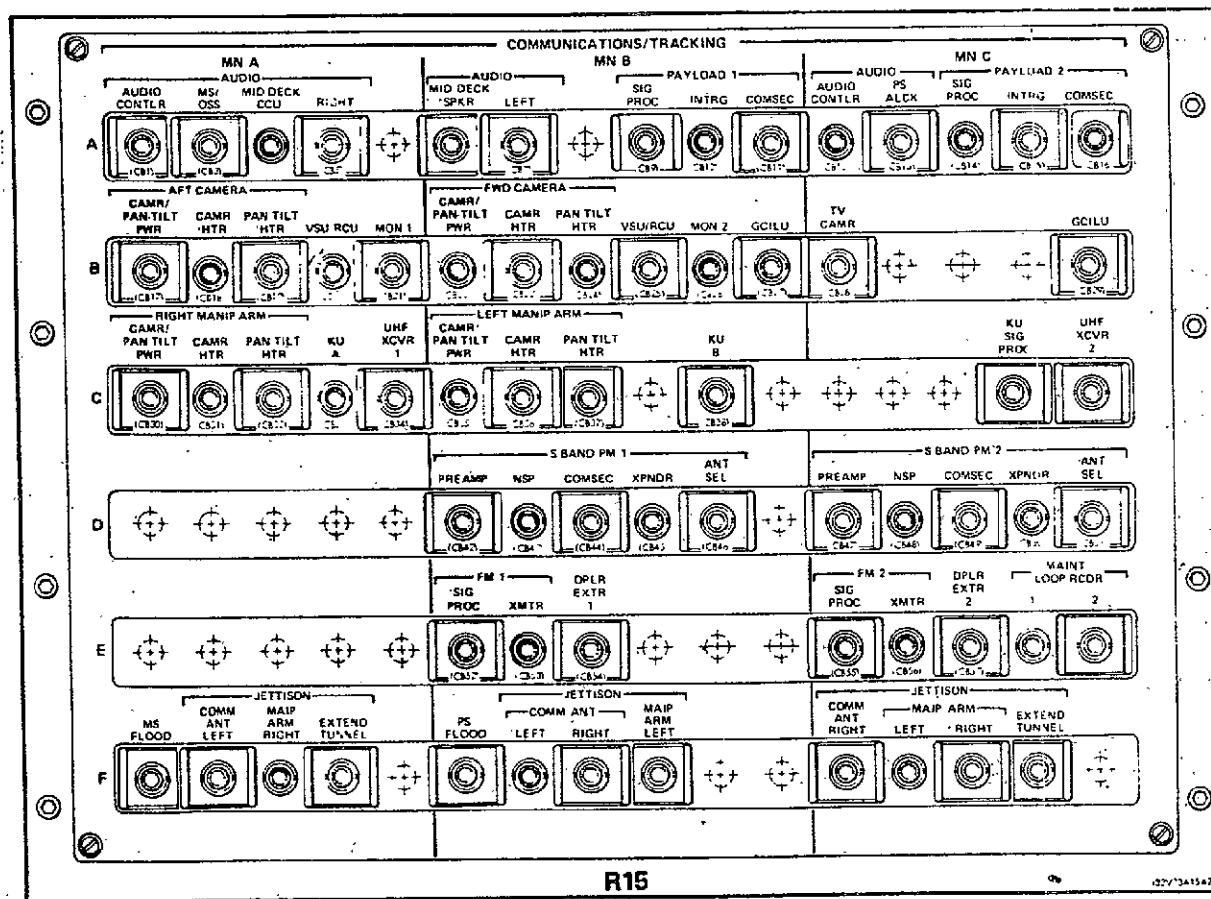
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PWL R15

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